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Bulletin
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American Ceramic Society

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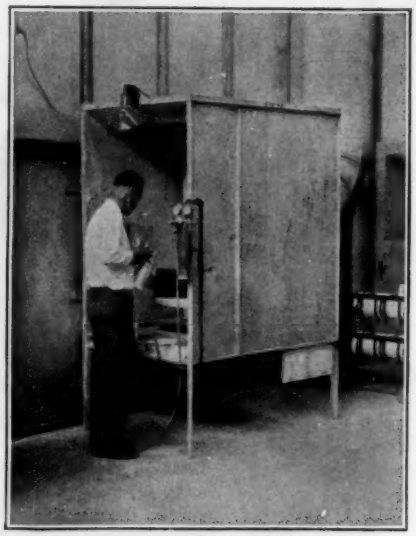

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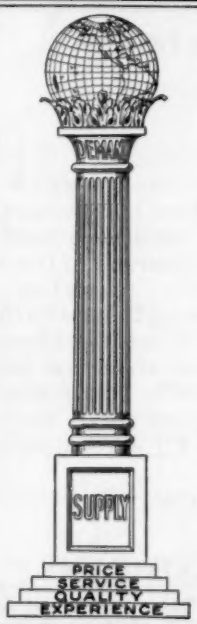

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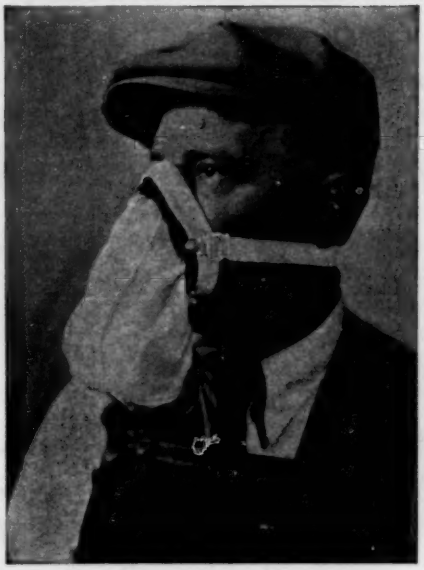

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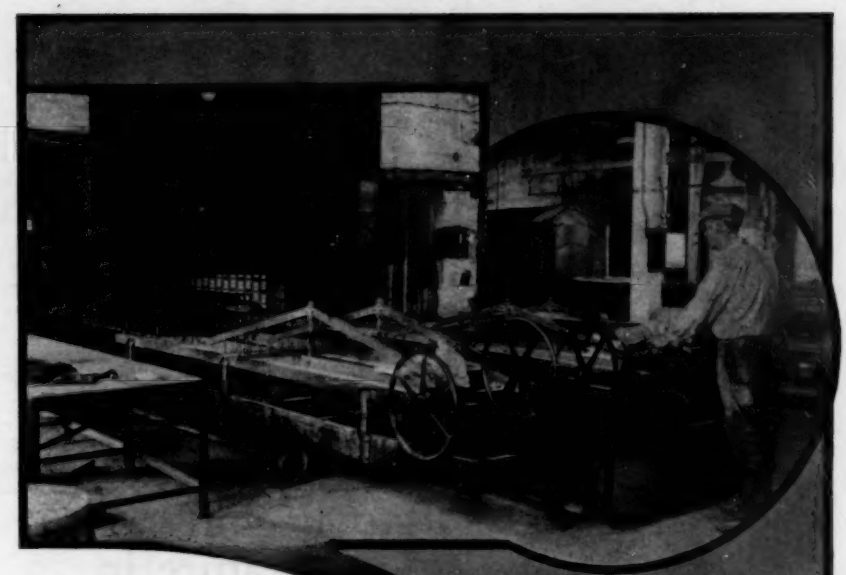

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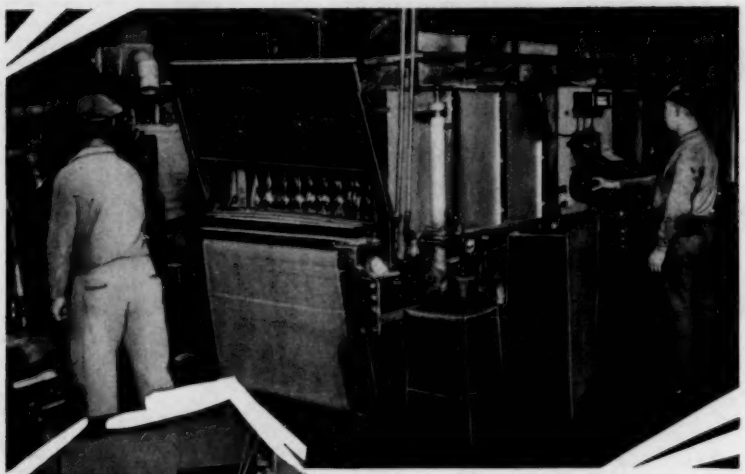

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A PORTABLE PYROMETRIC CONE EQUIVALENT FURNACE[1]

By Vance Cartwright[2] and Stuart M. Phelps[3]

ABSTRACT

A description is given of the development of a portable P.C.E. furnace that can be operated on natural gas or propane which can be purchased in tanks. The A.S.T.M. rate of heating is easily maintained and cone 38 can be brought down. The cost per run to cone 34 when using compressed gas is less than $1.00, while with natural gas the cost is about one-tenth as much.

Introduction

For clays used in refractories, the best single control test of variations in character of clay in a given deposit is the pyrometric cone equivalent. For this purpose the furnace to be described has been developed. It is portable and requires only electric current and a tank of gas for operation. Its operation is simple. With it, P.C.E. determinations can be made sufficiently accurate for control work.

Fuel Used The furnace was designed to use compressed gas. Although this fuel is expensive its cost is not excessive for the purpose. The most suitable gas is that composed principally of propane which can be burned with low-pressure air, has a high flame temperature, a heat value of 2700 B.t.u. per cubic foot, and a long flame. It is sold in 50- or 100-pound tanks under a pressure of 250 pounds per square inch.

Usual P.C.E. Pot Furnace The most common design of gas-fired P.C.E furnace is the pot furnace. The diagram shown in Fig. 1 represents a cross-section of such a furnace, except that the lid has been hollowed out to form a radiating surface to the top of the pedestal. It is usually fired with a single tangential burner. Usually it is quite temperamental and the diameter and height of the pedestal are not easily adjusted to secure uniform high temperatures without occasionally blowing the cone pats off the pedestal.

Development Studies Made

A study of the variables showed that the size and shape of the burner were important since a large burner opening causes a flashback, whereas if too small, it permits of insufficient fuel except by use of too much pressure. Rectangular burner openings increase the maximum temperature because they allow the gas to enter the furnace without impinging on the pedestal. The use of two burners in place of one gives more uniform and

[1] Received July 7, 1930.

[2] Industrial Fellow, Refractories Fellowship, Mellon Institute of Industrial Research, Pittsburgh, Pa.

[3] Senior Industrial Fellow, Mellon Institute.

higher temperature. The height of the pedestal is always critical and a change of $^1/_4$ inch will affect the maximum temperature.

With the usual pot furnaces a sufficiently high temperature could not be obtained with the available air pressure. The maximum temperature must be about 1750°C to bring down cone 33 and the air pressure is limited by the available blower equipment.

Surface Combustion Type A furnace much different in design from the usual pot furnace is shown in Fig. 2. This furnace operates on the principle of "surface combustion"; the gases

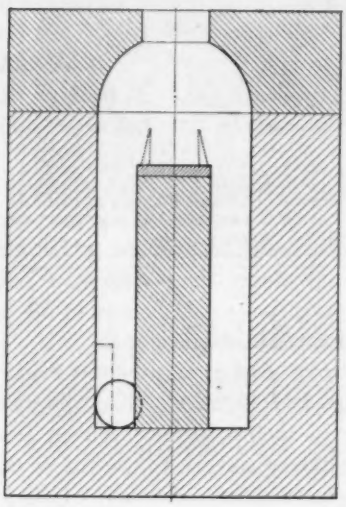

FIG. 1.

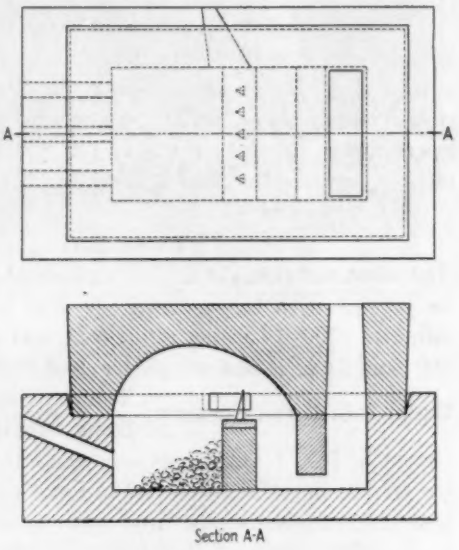

FIG. 2.

are ignited on hot refractory particles and, after passing the cone pat, go down and out the flue. The curvature of the arch radiates heat to the cone plaque placed on the baffle. The maximum temperature obtained with three burners was 1680°C, but the back pressure and gas consumption were slightly higher than those of the pot furnaces. Reducing the area of the burner openings increased the efficiency but the temperature was not increased. Four burners were necessary to obtain 1700°C.

The furnace in Fig. 3 showed little advantage. Attaching a stack for the exit gases did not reduce the back pressure. The solid bag-walls were removed and a porous mixture substituted. This increased the maximum temperature somewhat. This general type of furnace could be developed into a satisfactory equipment, except for the major problem of obtaining a satisfactory refractory.

Development of Final Furnace

Taper Design After experimenting with several furnaces it was decided to concentrate on the usual pot-furnace type. Figure 4 shows an improvement over the straight cylindrical design. Two burners

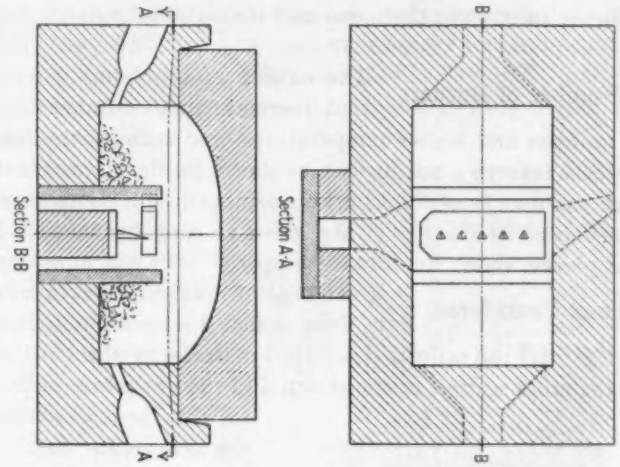

FIG. 3.

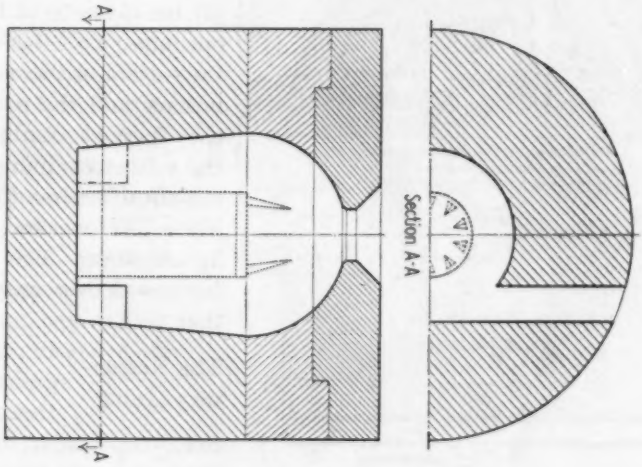

FIG. 4.

of rectangular cross-section were introduced and the interior redesigned. The furnace gradually increases in size from the bottom to the beginning of the arch to give a longer path for the flame and to reduce the velocity of the gases in the upper portion of the furnace. This lowered velocity of the gases at the top largely overcomes the difficulty of blowing the cone pats off the pedestal.

Higher temperatures were obtained because of more complete combustion and the radiation of heat from the crown to the pedestal which is an important factor.

Various designs were tried to eliminate the central flue by allowing the gases to escape at other positions in the furnace. These designs, however, made it difficult to observe the cones and they also introduced refractory problems.

Increased Number of Burners The earlier experimental work showed that increasing the number of burners gave more uniform and higher temperatures, and reduced the back pressure. For these reasons a pot furnace as shown in Fig. 5 was constructed. This furnace has four tangential burners arranged on a common manifold to insure uniform distribution of the gases to each burner. A layer of insulation is placed about the furnace proper.

Design Factors Considered A great deal of detailed experimental work was done which disclosed the following important factors: (1) the ratio of the diameter to the height, (2) the rate of increase in the cross-section to the crown and the curvature of the crown, (3) the diameter of the flue or the hole in the lid, (4) height and diameter of the pedestal, (5) the diameter of the burner openings, (6) the nature of the surface of the inside of the furnace and the pedestal, (7) the thermal conductivity of the refractory lining, and (8) the effectiveness of insulation. These factors are important in obtaining high temperatures with low gas consumption.

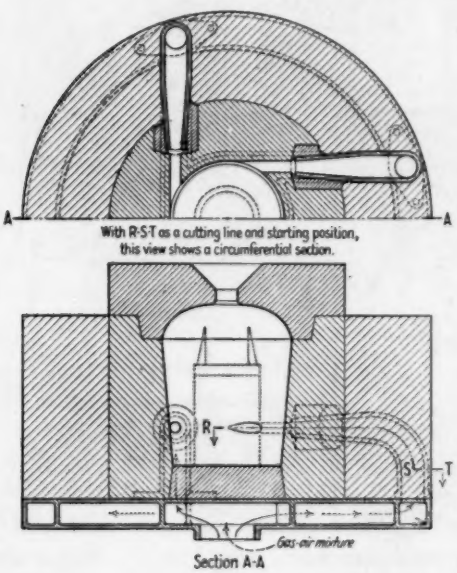

FIG. 5.—Portable fusion furnace.

The Refractory Lining In the earlier designs the refractory was made up as a unit or in sections and the burners were later cemented into position. This was not satisfactory because shrinking and expanding caused leaks around the burner.

It was soon realized that the ideal lining would be one that could be tamped into place with the burners in position. The burners were attached

to a templet and assembled with the necessary form for molding. A cylinder of sheet aluminum was inserted to permit independent tamping-in of the refractory material and the insulation. The sheet aluminum melted away leaving space for expansion and contraction.

After drying, the templet was removed and the manifold casting attached. This casting served as the base for the furnace.

The refractory which proved most satisfactory was composed of calcined diaspore 50%, fused alumina 34%, and plastic clay 16%, made up to dry-press consistency. A more refractory mixture using higher percentages of fused alumina would increase heat conductivity undesirably.

After molding, the inner surface of the furnace was roughened. This increased the surface combustion and increased the temperatures from 50 to 100° above those obtained with smoothly-molded surfaces.

The Insulation The high-temperature insulating material was composed of diaspore (lightly calcined) 80% and calcium aluminate cement 20%. Although this mixture was not as good an insulator as could be obtained by using a number of other materials, it resisted shrinkage and formed a mechanically strong section about the refractory lining.

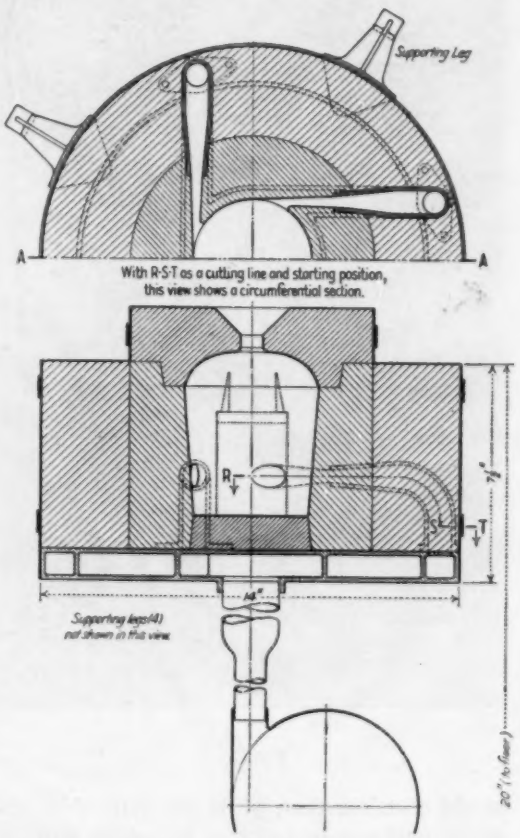

FIG. 6.

The Final Design

The Burners The furnace in its final design is represented in Fig. 6. The burners in this furnace were cast from a high-temperature alloy that withstands temperatures up to 1100°C. The

central position of the blower and the symmetry of the manifold casting insured uniform distribution of the gas mixture to the burners.

Assembled Unit

Figure 7 represents a photographic view of the complete furnace and also shows a 100-pound cylinder of the propane gas. The furnace weighs about 110 pounds and can be used at any suitable place in the plant or at the mine, since all that is required to operate it is a 110-volt circuit.

FIG. 7.

The rheostat is used to regulate the speed of the motor, and this, along with the shutter box, makes it possible to adjust the volume of air from 200 to 4500 cu. ft. per hour. The gas and air are mixed in the blower which insures a perfect mixture of the fuel. The blower unit is a high-speed type and, although its capacity is comparatively low, it will deliver 4000 ft. per hour at a pressure of five inches of water.

Fuel Required

Runs conducted on the A.S.T.M. heating schedule, using propane gas required 55 cubic feet of gas, which would cost less than $1.00 per run. Natural gas, with a B.t.u. value of about 1000 required 153 cu. ft., which reduced the cost to about one-tenth that of the propane. The cost of making a run is well within the practical limits even when compressed gas is used, since 14 cones can be put in a plaque.

Heating Performance

No difficulty is experienced in maintaining the proper rate of heating and cone 34 can be obtained with either fuel. By the introduction of small amounts of oxygen,

temperatures as high as cone 38 can be obtained, but this is hard on the furnace lining and is not recommended as a regular practice.

The analysis of the flue gas showed that, within experimental error, the combustion was complete from about 500°C, until cone 32 was down. After cone 32 was down, 0.03% of carbon monoxide was present.

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DRIER PROBLEMS WITH CALCULATIONS[1]

By John L. Carruthers

ABSTRACT

The importance of proper drying of clayware and some of the causes of drier troubles are discussed briefly. The use of a humidity chart in control and design problems is described. The Carrier humidity chart is used in illustrating the solution of several typical problems, *viz.*, air and heat requirements and the control of condensation in waste-heat and radiated-heat types of driers.

Introduction

Continuous tunnel driers of either the waste-heat or radiated-heat type are extensively used in the ceramic industry, especially in the manufacture of brick and hollow tile. The losses in ware, time, fuel, and investment due to improper drier design and operation undoubtedly add many thousands of dollars to the cost sheets of clay products manufacturers. The problem of proper drying is one that should command the attention and respect of every clay plant operator.

Object It is proposed to discuss drier operations in general and to show a few relatively simple methods of solving some of the problems that arise in the control and design of some continuous tunnel type driers. The solution of the problem will generally indicate the procedure necessary to follow in the design problem or to control the drying operation. It is impossible, within the limits of this article, to discuss the application of the solutions to all particular problems.

Drier Problems The manufacturer of clay products is using several materials, agencies, and forces of nature which may vary from day to day, thus complicating some of the manufacturing processes. Therefore, if uniform quality and production are to be continuously maintained, it is essential that a system of control be used. Proper control is likewise necessary for economical production.

The proper selection, mixing, and blending of the raw materials is the first step in producing good ware. Numerous drier problems that arise would be eliminated if the winning of the raw materials had been properly done. Changes in various manufacturing processes such as grinding, screening, tempering, and forming, affect the physical characteristics of the green ware. If the physical properties of the green ware are kept uniform, then the matter of obtaining well-dried brick economically is a problem of drier control only. Maintaining uniform time, temperature, and humidity relations in the drying system will produce uniformly dried ware only if the ware is constant in physical properties. Practically all driers are sufficiently flexible in control so that various drying conditions

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Heavy Clay Products Division). Received August 18, 1930.

may be obtained. Once the proper condition has been established, however, for a given type of ware, it should be continuously maintained.

A drier, properly designed and built, is necessary in the production scheme in order that the ware may be dried safely, thoroughly, quickly, and economically. The drying system must be capable of supplying sufficient heat for the process and a proper quantity of air to sweep away the water vapor produced. Also, controls must be provided to regulate the amount of heat and air introduced, so that constant time, temperature, and humidity conditions are maintained. The manner in which the heat is brought to the ware and the vapor carried away is also most important, and will depend entirely upon the structural arrangements in the drier and the setting of ware on the cars. The drier controls should be operated either manually or automatically at the time that changes occur in the system, *i.e.*, in atmospheric conditions or the rate of drying.

Humidity Charts

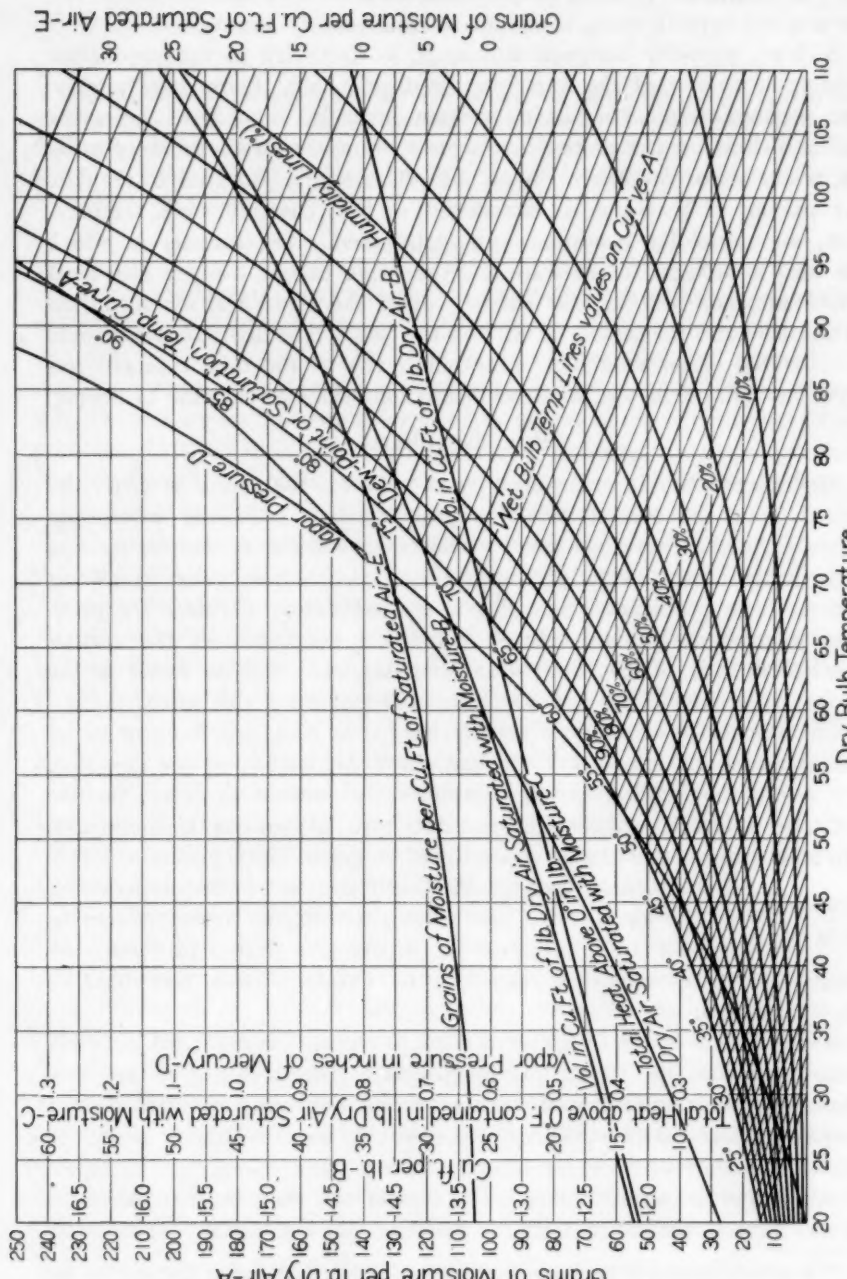
Modern practice in engineering work calls for the use of properly designed charts for solving recurring problems that ordinarily entail considerable work. Several humidity charts have been devised for heating and ventilating problems and are also of considerable value in solving various drier problems. Such charts are sufficiently accurate for problems in drier design and control. Complete discussions of the various charts, methods of use, derivation formulas, etc., will be found in the books and articles in the list of references at the end of this paper.

The Carrier psychrometric chart[2] (Fig. 1) is used here because of its completeness and simplicity. In this chart, a constant of one pound of dry air is used. This greatly simplifies the various problems dealing with air volumes, water-vapor content, etc., at various temperatures. The vapor content of the air is expressed in grains (7000 grains = 1 lb.).

Required Data It is essential that the dry-bulb and wet-bulb temperatures of the air entering and leaving the drying system either be known or be assumed in control and design problems, respectively. The remaining data can be obtained from the chart or physical tables.

Some form of a psychrometer is used to obtain the dry- and wet-bulb temperatures of the air at various points in the drying system. Two stationary thermometers (one with a wetted bulb) may be used in drier tunnels or ducts, if the velocity of the moving air is relatively high. In still or slow moving air it is necessary to use either a sling type or an aspiration type of psychrometer. The former can only be used in places where there is sufficient room for whirling the instrument. The latter

[2] Acknowledgment is hereby made to the Carrier Engineering Corporation for permission to use this chart.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Grains of Moisture per Cu Ft of Saturated Air-E
Grains of Moisture per Cu Ft of 1 lb Dry Air-B
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Total Heat above 0° F contained in 1 lb Dry Air-C
Total Heat Above 0° in 1 lb Saturated with Moisture
Vapor Pressure-D
Dew-Point or Saturation Temp Curve-A
Wet Bulb Temp Lines varies on Curve-A
Humidity Lines (%)

FIG. 1.

type is useful for tunnel and duct work. Indicating and recording thermometers (both dry and wet bulb) of several different types can also be used.

Initial Drying Temperatures and Condensation

Maximum efficiency in continuous tunnel driers of the waste-heat type is obtained when the minimum weight of hot air per unit weight of ware is handled by the fan system. In driers of the radiated-heat type (combustion gas or steam radiators), the efficiency depends upon the weight of fuel consumed.

To obtain high efficiency in the waste-heat drier, the water-vapor content of the exhaust air must be as high as possible, consistent with the other factors entering into the problem. The same is true of the radiated-heat drier, and in addition a minimum volume of air should be handled to reduce fuel consumption.

The amount of water vapor that can be safely carried by the air exhausted from a drier will be governed by the dew-point temperature of the exhaust air and the temperature of cold green ware coming in contact with this humid air. If the temperature of the ware is below the dew-point temperature of the exhaust air, then condensation of water vapor on the ware and cars will take place. Therefore, ware entering the drier with a temperature of about 80°F can be dried with air of greater water content than can ware with a temperature of only 75°F. The difference in this case would amount to 24 grains of water per pound of dry air handled in the system. This indicates that warming the chambers or preheating the ware in the forming process can be used to increase the efficiency of the drier. A considerable amount of condensation in the driers can be prevented by placing the green ware directly into the drier after it leaves the machine because wet ware standing in the open air will be reduced in temperature due to surface evaporation.

Every possible precaution should be taken to prevent condensation, since it is a factor in the development of drier scum; cracking, slumping, and warping of the ware are also promoted by condensation. Manufacturers of hollow tile can eliminate most surface blisters or blebs by preventing condensation, since the softening of the surface of the ware by condensed vapor and the expansion of entrapped air bubbles by heat are the primary causes for the development of the surface blebs.

The humidity of the air coming in contact with the green ware (generally the exhaust air) will govern the rate of drying in the system. With a fixed dew-point temperature, high humidities (slow drying) are obtained with low dry-bulb temperatures, and low humidities (faster drying) with higher dry-bulb temperatures. In each case, the same weight of air will be required per unit weight of water removed from the ware, but the

volume of air per unit time and the heat required per unit will be greater in the latter case. The drying period or rate is governed by the drying characteristics of the ware and clay in process.

Figure 2 is used to illustrate the preceding discussion; also, the manner of using the psychrometric chart in problems of this type is explained in Problem I and Fig. 2.

Problem I

To find the dew-point temperature of drier exhaust air to prevent condensation; also to show the effect of variation of dew-point temperature on the amount of air and heat required for drying.

Data: Waste-heat drier; atmospheric conditions 70°F and 50% humidity (A); air leaves the drier with dry-bulb temperature of 80°F (B), 90°F (C), and 100°F (D). In each case the dew-point temperature is the same. Temperature of the ware entering the drier is 81°F.

Points *B*, *C*, and *D* on Fig. 2 refer to the exhaust air conditions given in the data.

Solution with Discussion Since the ware enters the drier at 81°F, the dew-point temperature of the exhaust air must be below that of the ware. The dew-point temperature for any hygrometric condition is found on the chart by first locating the intersection of the dry- and wet-bulb temperature lines for that condition and then projecting that point horizontally to the left until it intersects curve *A*. This point of intersection represents the dew point and may be read on the dry-bulb temperature scale. In this case, the dew-point temperature must be assumed and dry- and wet-bulb temperatures chosen for the drying rate desired. A dew-point temperature of 80°F (*B*) will be chosen, and will be satisfactory. Then any hygrometric condition along the horizontal line to the right, or air carrying 154 grains of H_2O per pound of dry air will have a dew point of 80°F, as represented by points *B*, *C*, and *D*, and condensation cannot take place.

On Fig. 2, *A* represents the hygrometric conditions of the atmosphere. The water removed from the ware in the drier will be the difference between that in the exhaust air and the air entering the system, or 100 grains (154–54) per pound of dry air handled. If a dew-point temperature of 70°F (*F*) had been used, then only 54 grains (110–54) of water per pound of dry air would have been removed. If the dew point, however, could be raised to 87°F (*E*), then each pound of dry air used would remove 134 grains of water from the ware. Compared with the 80°F dew point, the 70°F dew-point air requires an increase of 96% in the poundage of air handled, while the 97°F dew-point air requires 18% less air.

These figures have a real significance, when it is realized that 70,000 lbs. of dry air would be required to dry 1000 brick (with each brick losing one pound of water) under the conditions marked *A* and *B* on the chart.

Variation in Heat Required

The total heat contained in one pound of dry air with its accompanying water vapor can be found on the chart as follows. From the point on the chart representing the hygrometric condition of the air (take point *C*), move upward to the left along the wet-bulb temperature line to the point of intersection, *C'*, with curve *A*, then project vertically until curve *C* is intersected (point *C''*), and read value in B.t.u. on scale at left (45 B.t.u.). Figure 2 shows that the outside air contains 24.8 B.t.u. per pound of dry air (with 54 grains of H_2O vapor). Air leaving the drier under condition *B* would

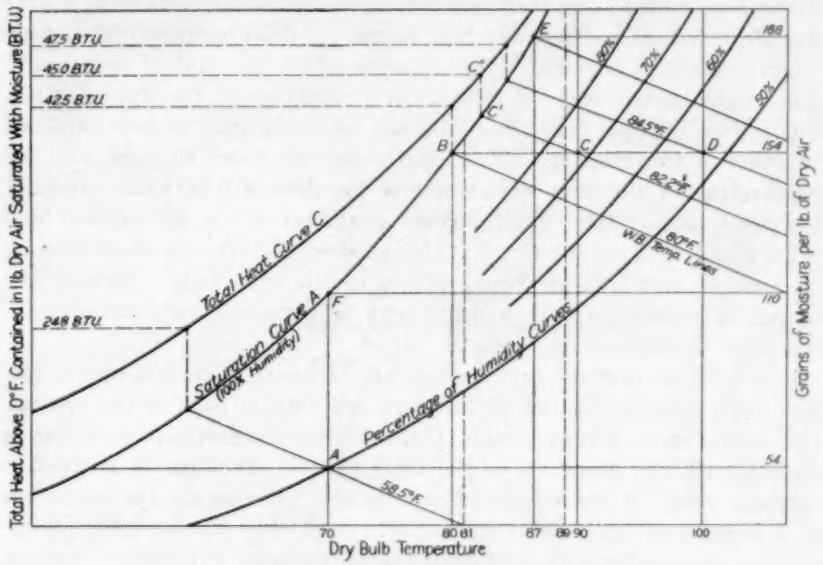

FIG. 2.—Portion of Carrier psychrometric chart.

require 17.7 B.t.u. (42.5–24.8) per pound of dry air handled to raise the temperature of 1 pound of dry air from 70 to 80°F and to evaporate 100 grams of water. For exhaust air under condition *C*, 20.2 B.t.u. (45.0–24.8) would be needed per pound of dry air handled. For point *D*, 22.7 B.t.u. (47.5–24.8) would be required. On the basis of 70,000 lbs. of dry air required per M brick, the heat used per M brick as sensible heat of air and latent heat of evaporation will be 1,239,000 B.t.u., if the exhaust air is 80°F (dry-bulb temperature) and 1,750,000 B.t.u., when the exhaust air is 100°F(dry-bulb). Additional heat will be required for items such as sensible heat of water evaporated, heat carried from the drier by cars and ware, and the heat lost by radiation.

The above problem and discussion indicate that a high dew-point temperature of the exhaust air is necessary for efficient operation of con-

tinuous tunnel driers, and that such a condition may be had with either slow or fast drying. A high dew-point temperature requires smaller volumes of air with heat requirements about the same. A thorough study of many of our present driers will indicate various conditions or features that can be easily improved and thus economically raise the efficiency of the drying system.

Influence of Atmospheric Conditions on Drier Operation

A change in the temperature, humidity, or barometric pressure of the atmosphere from a given condition will have a marked effect on the operation of waste-heat and radiated-heat driers. If drier temperatures and air volumes are held constant, these changes affect the rate of drying and either damage the ware or reduce the production of the drier. When atmospheric changes take place, the rate of drying may be held constant by either of two methods. First, the poundage of dry air used, and the temperature at the ware outlet end of the drier will be varied and the dew-point temperature and humidity condition at the air exhaust end of the tunnel held constant. This change alters the velocity of air through the tunnels and finishing temperatures of the ware only. Second, the volume or poundage of air handled may be kept constant, and all temperatures throughout the system varied.

It is believed that the first method will be easier to control within certain limits provided a fan of sufficient capacity is part of the system. The second method is applicable, if the ware is warmed before coming in contact with the moist air in the drier tunnel. Problem II is used to illustrate some of the effects of atmospheric changes on the operation of a waste-heat drier and also indicates somewhat the flexibility necessary in the heat-supply and air-blowing systems, if constant uniform drying conditions are to be maintained. A waste-heat or radiated-heat drier, in which the temperatures at the ware outlet end are held constant and the air adjustments not changed, will of itself tend to maintain a constant drying rate along the lines of the second method of control described. There will be, however, either a lot of ware damaged due to too rapid a drying rate or the production of the drier will be materially lessened.

Problem II

To find the volume of air and amount of heat required to operate a waste-heat drier with varying atmospheric conditions and constant exhaust air temperature and humidity.

Data: Drier production, 40 M brick per day (24 hrs.); weight of dry brick, 5 lbs.; weight of water evaporated from each brick, 1 lb.; exhaust air (D) 100° (dry bulb) and 54% humidity. The cars and ware enter the drier at 81°F.

Atmospheric conditions (*a*) 40°F (dry bulb) and 80% humidity, (*b*)

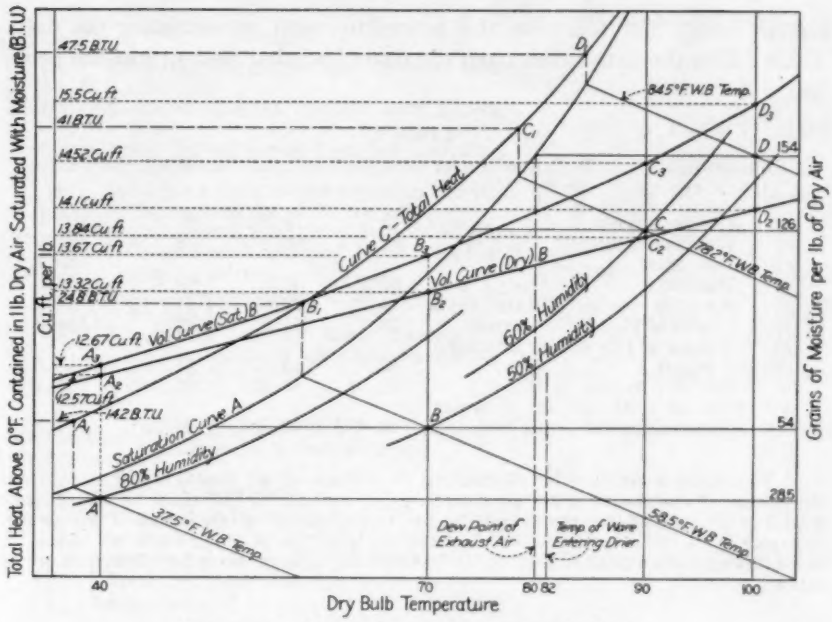

FIG. 3.—Portion of Carrier psychrometric chart.

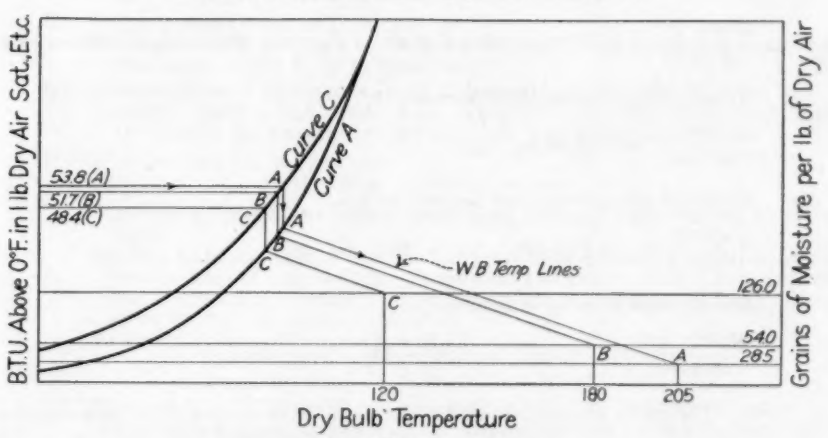

FIG. 4.

70°F (dry bulb) and 50% humidity, and (*c*) 90°F (dry bulb) and 60% humidity. Number of brick per drier car, 500; weight of drier car, 500 lbs.; radiation losses estimated as 10% of the total heat supplied to the drier.

The temperature of the hot air delivered to the drier and the temperature of the ware and cars leaving the tunnels will vary in each case, but will be figured for each condition. Figures 3 and 4 are portions of the

Carrier chart and illustrate the procedure used in obtaining the data. Table I lists the data taken from the chart and that assumed in the problem.

TABLE I

(Columns marked A, B, C, and D refer to various air conditions listed under data.)

Item		A	B	C	D
(*a*)	Dry-bulb temp.	40°F	70°F	90°F	100°F
(*b*)	Wet-bulb temp.	37.5°F	58.5°F	78.2°F	84.5°F
(*c*)	Dew point				80°F
(*d*)	Humidity	80%	50%	60%	54%
(*e*)	B.t.u./lb. dry air + water vapor	14.2	24.8	41.0	47.5
(*f*)	Grains of H_2O/lb. of dry air	28.2	54.0	126.0	154.0
(*g*)	Volume of 1 lb. dry air saturated (cu. ft.)	12.67	13.67	14.52	15.5
(*h*)	Vol. of 1 lb. dry air (cu. ft.)	12.57	13.32	13.84	14.1
(*k*)*	Vol. of 1 lb. dry air + water vapor (cu. ft.)	12.65	13.50	14.25	14.86

* This value is obtained by subtracting the volume of one pound of dry air (*h*) from the volume of one pound of dry air saturated (*g*), multiplying difference by the per cent humidity (*d*), and adding the figure obtained to the volume of one pound of dry air (*h*). Example (*a*) [(12.67–12.57) × 0.8 + 12.57 = 12.65 cu. ft.]. (NOTE: All values in the following calculations will be on the basis of one minute, since fan capacities are so rated.)

Water evaporated from ware per minute =

(*l*) $\frac{40{,}000 \times 1}{24 \times 60} = 27.77$ lbs. or 194, 444 grains of H_2O/min. to be evaporated from ware

(*m*) Weight of clay leaving drier per min. =

$$\frac{40{,}000 \times 5}{24 \times 60} = 138.88 \text{ lbs./min.}$$

(*n*) Weight of cars leaving drier per minute =

$$\left(\frac{40{,}000}{500} \times 500\right) \div (24 \times 60) = 27.77 \text{ lbs./min.}$$

(*o*) Sensible heat of water evaporated =

$$\frac{40{,}000 \times 1}{24 \times 60} \times 1 \times (84.5 - 81.0) = 127.2 \text{ B.t.u./min.}$$

NOTE: The initial temperature of the water is the same as that of the ware entering the drier, *viz.*, 81°F. The evaporating temperature is assumed to be the same as the wet-bulb temperature of the exhaust air. This item constitutes only a small percentage of the heat used and can ordinarily be omitted.

Item	Results	Atmospheric conditions A	B	C
(*p*)	Grains of H_2O evaporated/lb. of dry air	125.5	100.0	28.0
(*q*)	Lbs. of dry air/min. required in drier	1549.3	1944.4	6944.4
(*r*)	Vol. of air required at exhaust temp. (*D*)	23,000	28,900	103,000
(*s*)	B.t.u./lb. dry air for evaporation and sensible heat of air	33.3	22.7	6.5
(*t*)	Total B.t.u./min. for item (*s*) in drier	51,590	44,140	45,140

Item	Results	Atmospheric conditions A	B	C
(*u*)	B.t.u./min. carried by cars and ware from drier	3520	3010	985
(*v*)	Assumed temp. of car and ware leaving drier	185°	170°	110°
(*w*)	Total B.t.u. required except radiation losses	55,110	47,150	46,125
(*x*)	Total B.t.u./min. required to operate drier	61,230	52,390	51,250
(*y*)	B.t.u. required/lb. of dry air used	39.6	26.9	7.4
(*z*)	B.t.u. above 0°F required in 1 lb. of dry air and accompanying water vapor at drier air inlet	53.8	51.7	48.4
(*aa*)	Required temperature of inlet air to drier (approx.)	205°	180°	120°
(*bb*)	Volume of air at inlet temperature (cu. ft./min.) at standard barometric pressure	26,600	34,000	112,300

Explanation of Calculations All figures in the following data are taken from the various items in column A except as noted.

To solve for item marked

(*p*) Subtract item (*f*) from item (*f*) in Column D.
The latter figure is used to obtain (*p*) in Columns A, B, and C.
Example: 154.0 − 28.5 = 125.5 grains of moisture from ware/lb. of dry air used in the system.

(*q*) Divide item (*l*) by item (*p*)
Example: $\frac{194,444}{125.5}$ = 1549.3 lbs. of dry air/min. required to operate drier.

(*r*) Multiply item (*k*) under D by item (*q*)
Example: 14.86 × 1549.3 = 23,000 cu. ft./min. air required to be exhausted from drier at 100°F, 54% humidity.

(*s*) Subtract item (*e*) Columns A, B, or C from item (*e*) Column D.
Example: 47.5 − 14.2 = 33.3 B.t.u. required to evaporate 125 grains of H_2O and to raise the temperature of 1 lb. of dry air from 40 to 100°F.

(*t*) Multiply item (*s*) by item (*q*).
Example: 33.3 × 1549.3 = 51,590 B.t.u./min.

(*u*) This item represents the sensible heat in the cars and ware removed from the drier.
Sensible heat = mass × rise in temperature × specific heat of material. Specific heat of iron = 0.12. Specific heat of clay = 0.22. Temperature rise is difference between item (*v*) and initial temperature of ware. Mass of ware, item (*m*) mass of cars, item (*n*).
Example: (185 − 81) × 0.12 × 27.77 = 347
(185 − 81) × 0.22 × 138.88 = 3173
Total for item (*u*) = 3520 B.t.u./min.

(*v*) (Estimated) Go through the remaining calculations roughly to obtain an approximate figure for item (*aa*) and then subtract 10 to 20° from that figure, depending on whether the temperature is low or high, respectively.

(*w*) Add items (*t*) and (*u*).
Example: 51,590 + 3520 = 55,110 B.t.u./min.

(*x*) Divide item (*w*) by 0.9, since it was originally assumed that the radiation losses are 10% of the total heat furnished to the drier.
Example: $\frac{55,110}{0.9}$ = 61,230 B.t.u./min. or the total heat that must be added to the atmospheric air to accomplish drying of the ware.

(*y*) Divide item (*x*) by item (*q*)
Example: $\frac{61,230}{1549.3}$ = 39.6 B.t.u. to be added to each lb. of dry air + water

vapor used from the atmosphere outside the drier.

(z) Add item (e) to item (y)
Example: 39.6 + 14.2 = 53.8 B.t.u. above 0°F necessary in each lb. of dry air + water vapor used in system.

(aa) Use chart. Start by locating value of item (z) on left hand side of chart; move horizontally to right until curve C is intersected; project vertically to curve A. From this point, follow wet-bulb temperature line to point of intersection with horizontal line representing value of item (e), see Fig. 4. Follow lines marked *A-A-A-A*, *B-B-B-B*, and *C-C-C-C*.

(bb) Use the following formula
$bb = MV_1$, in which M is the value given in item (q).
V_1 is obtained by using the following formula:

$$V_1 = \frac{VT_1}{T}$$

Where V = volume of 1 lb. of dry air + water vapor at atmospheric conditions (item k).
T = absolute temperature of air at atmospheric conditions.
T_1 = absolute temperature of air entering drier at temperature listed under item (aa)

Example: $V_1 = \frac{12.65 \times (460 + 205)}{(460 + 40)} = 16.83$ cu. ft.

$bb = 1549.3 \times 16.83 = 26{,}100$ cu. ft. of air/min. at 205° required to dry 40,000 brick per day under conditions stated.

The Effect of Barometric Pressure Changes

The Carrier psychrometric chart is based on standard barometric pressure, namely, 29.92 in. of Hg. If any other pressure must be considered, then a correction of the air-volume factors would have to be made. None of the heat values or air-moisture content values are affected since they have a constant base, *e.g.*, one pound of dry air. The following example will illustrate the manner of correcting air volumes found by means of the chart.

Example: 30,000 cu. ft. of air/min. at 70°F and 29.92 in. Hg required for a drier. What will be the volume required if the barometric pressure is 28 in. of Hg?

$$V_1 = \frac{VP}{P_1} = \frac{30{,}000 \times 29.92}{28.0} = 32{,}050 \text{ cu. ft./min.}$$

V = volume at standard barometric pressure
V_1 = volume at actual barometric pressure
P = standard barometric pressure (29.92 in. of Hg)
P_1 = actual barometric pressure.

Remarks There are several methods that may be used in solving drier problems, shown in the various articles, etc., given in the list of references. Generally, these methods will not agree exactly in the final results obtained because of the differences in assumptions made. Any of the methods will give results sufficiently accurate for all practical purposes. It is believed that the methods used in this article are simple and provide for the acquisition of all necessary data in drier design and control problems.

In Problem II, the temperature of evaporation was assumed to be the wet-bulb temperature of the exhaust air. While this temperature may be

somewhat low, it does not seriously affect the calculations. According to Carrier and Lindsay,[1] the temperature of a liquid evaporating is that of the wet-bulb temperature of the air furnishing the heat for evaporation. Consequently, for best results, the temperature of green ware coming in contact with the humid air of the drier should be approximately that of the wet-bulb temperature of the air. This condition may be obtained by heating the ware, without appreciable evaporation before it comes in contact with the air in the drier, and any one of several methods may be used to bring about this condition. As previously stated, however, the temperature of the ware must not be below the dew-point temperature of the air at the ware-entering end of the drier.

The results obtained in Problem II show quite clearly the variation in air volume and heat required for different atmospheric conditions. It would be somewhat impractical to maintain a fan for the capacities indicated by the problem. Conditions shown under "C," for example, corresponding to a hot summer day with high humidity, affect the drying operation most seriously. If the large volume of air required was not available, then the production of the drier would be reduced unless the dew-point temperature of the exhaust air was increased sufficiently to maintain the normal rate of evaporation.

The volume of air that can be put through a radiated heat drier generally depends upon the capacity of the drier stack. This capacity is governed by the height and inside dimensions of the stack, and the difference in weight between unit volumes of the outside air and the stack gases. High atmospheric temperatures and humidities lower the capacity of a stack unless the temperature of the stack gases is increased in the proper amount. The general procedure used in calculating various items for the operation of a waste-heat drier may be applied to radiated heat-drier problems with only a few modifications.

Conclusions

The use of charts and calculations will simplify and shorten the procedure used in solving drier design and control problems. It has been shown that a number of factors have considerable influence upon the drying rate and efficiency of continuous tunnel driers. It is also apparent that most of the factors involved are varying from day to day and even during a single day, so that constant temperature and humidity conditions cannot be maintained and uniform drying of the ware still be obtained. It is essential, therefore, that a uniform drying rate be established and that temperature, volume, and humidity conditions be controlled to maintain that rate.

Once a definite drying rate and hygrometric conditions of the exhaust

[1] See Ref. 6, Bibliography, p. 20.

air have been established, then it is possible to obtain data or curves by means of calculations as shown here for controlling various temperatures and the volume of air needed.

It is true, that most of the present waste-heat and radiated-heat driers are operating in a manner that is apparently satisfactory. The size of the drier, the time required for drying, and the amount of fuel or volume of air required per unit of ware could be materially reduced, however, if proper standards and controls were maintained. It would also be possible to increase the percentage of good ware coming from the drier by eliminating cracking, warping, etc., caused by improper drying conditions. These results may be obtained only by thoroughly studying existing conditions and then applying the necessary corrections as indicated by the solution of the problems involved.

Bibliography

BOOKS

(1) Fan Engineering, 2nd ed. Published by Buffalo Forge Co., Buffalo, N. Y.
(2) Drying and Processing. Published by Carrier Engineering Corp., Newark, N. J.
(3) Gebhardt, Steam Power Plant Engineering, John Wiley & Sons, Inc., New York.
(4) Ellis Lovejoy, Drying Clay Wares, T. A. Randall and Son, Inc., Indianapolis, Ind.
(5) Clay Products Cyclopedia, Industrial Publications, Inc., Chicago, Ill.

ARTICLES

(6) W. H. Carrier, "Psychrometric Formulas," *Trans. Amer. Soc. Mech. Eng.*, **33**, 1005 (1911).
(7) W. H. Carrier, "The Theory of Atmospheric Evaporation," *Jour. Ind. Eng. Chem.*, **13** [57], 432 (1921).
(8) W. H. Carrier and D. C. Lindsay, "The Temperatures of Evaporation of Water into Air," *Trans. Amer. Soc. Mech. Eng.*, **46**, 739 (1924).
(9) A. E. R. Westman and R. G. Mills, "Some Waste-Heat Drier Calculations and Charts," *Jour. Amer. Ceram. Soc.*, **12** [3], 162 (1929).
(10) R. K. Hursh, "Heat and Air Requirements for Drying Clay Products," *Brick Clay Rec.*, Dec. 3, 1929.

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THE INFLUENCE OF CHEMICAL COMPOSITIONS ON THE PHYSICAL PROPERTIES OF SODA-LIME GLASSES[1]

By J. W. Gill and W. C. Rueckel

ABSTRACT

Nineteen soda-lime glasses covering the commercial field were prepared, melted, and fined for 2 hours. The chemical composition of the raw materials was determined by usual analytical methods; the refractive index was determined by an Abbé refractometer; density, by the normal suspension method; and softening point, by the Littleton method with the furnace as specified in *Jour. Amer. Ceram. Soc.*, **10** [4], 259–63 (1927).

The data indicate the following points: (1) When the silica was kept constant by increasing the dolomitic lime at the expense of soda an increase in softening point of 11 to 12°C per 1% increase was obtained. Likewise the density increases 0.004 and the refractive index 0.0015 per 1% increase of lime. (2) When the soda was kept constant the softening point was practically constant. The density decreases 0.011 and the refractive index 0.0030 per 1% increase of silica at the expense of lime. (3) When the lime was kept constant the increase in softening point per 1% increase in silica varied as follows: 5% lime 21°C, 8% lime 17°C, 10% lime 15°C, and 12% lime 12°C. The density decreased 0.008 and the refractive index 0.0015 per 1% increase in silica at the expense of soda. (4) A thermo-chemical relation of the softening points and the chemical compositions (calculated) closely paralleling the "liquidus" surfaces of Feild and Roysters' system: CaO–Na_2O–SiO_2.

Composition Range

The range of compositions was from 5 to 15% (Ca,Mg)O, 10 to 20% Na_2O, and 70 to 80% SiO_2. Arranged on a triaxial diagram (Fig. 1), the lines representing the limits of these ranges formed a hexagon and the corners, the compositions of six batches. The field was well covered by nineteen batches with several points in straight lines paralleling one of the sides of the triaxial thus keeping one component constant to permit a study of the effect of the variation of the other two.

The raw materials were furnished by the Federal Glass Company, Columbus, Ohio. The sand and soda-ash were of commercial purity, while the lime closely approximated the theoretical dolomitic ratio.

Procedure

Six-inch Denver fireclay crucibles were filled about three-quarters full of the carefully weighed and mixed batches, from 350 to 400 grams in each crucible. Duplicates were run on each batch and listed as *A* and *B*.

The nineteen glasses were divided into two groups. The ten batches in the area below the heavy line *AB* (Fig. 1) were melted at 2650°F and allowed to fine for two hours at that temperature. The nine batches above the line were the more refractory glasses and were melted at 2750°F

[1] Bachelor's Thesis, Ohio State University, 1930.

Presented at the Annual Meeting, American Ceramic Society, Toronto, Canada, February, 1930 (Glass Division). Received Feb. 6, 1930.

and fined for two hours at that temperature. The crucibles were removed at the respective temperature, thread drawn, and the mass allowed to cool. Pieces for density and refractive index were chipped from the melt.

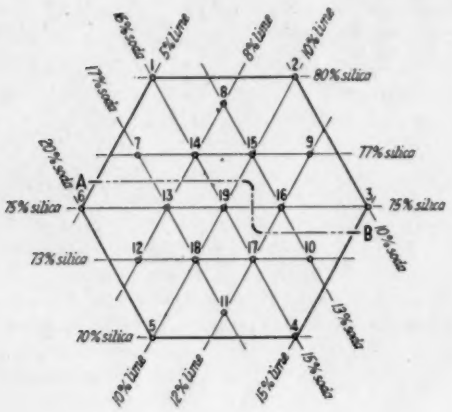

FIG. 1.

All of the batches in the first group melted and fined well, and smooth uniform rods were readily obtained. In the second group, Nos. 2 and 3 had some white scum on the surface, did not give good rods easily, and seemed to have short working ranges.

Softening Point The softening point determinations on the threads were run in a furnace built according to the specifications of Littleton.[2] After the tests were completed, check runs were made on the furnace and a maximum variation of only 5°C was found. An analysis of the data shows that two-thirds of the duplicates checked within 2°C, while practically all were within 5°C.

TABLE I

Softening points, °C	Batch number	Oxide composition (%) SiO_2	$(Ca,Mg)O$	Na_2O
795	1	80	5	15
847	2	80	10	10
851	3	75	15	10
749	4	70	15	15
699	5	70	10	20
690	6	75	5	20
729	7	77	6	17
793	8	79	8	13
815	9	77	12	11
777	10	73	14	13
744	11	71	12	17
724	12	73	8	19
727	13	75	8	17
752	14	77	8	15
776	15	77	10	13
776	16	75	12	13
763	17	73	12	15
744	18	73	10	17
749	19	75	10	15

Density The pieces selected for density and refractive index determinations were annealed in an electric furnace. They were heated slowly to 1100°F and then cooled at a rate not over 100°F per hour to

[2] J. T. Littleton, "A Method for Measuring the Softening Point of Glasses," *Jour. Amer. Ceram. Soc.*, **10** [4], 259 (1927).

800°F; from 800°F the temperature was allowed to drop at the normal cooling rate of the furnace.

The samples for density determinations were carefully selected from the top center portion of the glass to obtain bubble-free pieces. The determinations were made by the displacement method, care being taken to heat as small a portion as possible when joining to the platinum wire. Calculations were made to three decimal places. In the following table, values for 2B, 3A, and 3B are probably a little low due to the presence of a few small bubbles in the sample.

TABLE II

DENSITY DATA

Batch number	A	B	Av.
1	2.394	2.399	2.397
2	2.429	2.411*	2.420
3	2.514*	2.505*	2.510
4	2.524	2.521	2.523
5	2.501	2.501	2.501
6	2.442	2.447	2.445
7	2.419	2.427	2.423
8	2.360	2.359	2.360
9	2.445	2.446	2.446
10	2.493	2.487	2.490
11	2.493	2.493	2.493
12	2.472	2.468	2.470
13	2.462	2.461	2.461
14	2.444	2.440	2.442
15	2.448	2.448	2.448
16	2.474	2.476	2.475
17	2.488	2.483	2.486
18	2.478	2.478	2.478
19	2.466	2.466	2.466

* Indicates probable error due to bubbles.

TABLE III

REFRACTIVE INDICES

Batch number	A	B	Av.
1	1.4953	1.4965	1.4959
2	1.5021	1.5038	1.5029
3	1.5245	1.5238	1.5242
4	1.5253	1.5248	1.5251
5	1.5167	1.5178	1.5173
6	1.5038	1.5060	1.5049
7	1.4978		1.4978
8	1.4989	1.4999	1.4994
9	1.5138	1.5038	1.5088
10	1.5182	1.5184	1.5181
11	1.5169	1.5188	1.5179
12	1.5050	1.5092	1.5071
13	1.5070		1.5070
14	1.5015	1.5005	1.5010
15	1.5065	1.5055	1.5060
16	1.5117	1.5127	1.5122
17	1.5150	1.5155	1.5153
18	1.5115	1.5128	1.5122
19		1.5093	1.5093

Refractive Index

The specimens of glass employed for determining the refractive index were not selected from any particular part of the crucible, but were annealed as previously mentioned. Two surfaces were ground plane on the piece approximately at right angles to each other. One of these was also polished until it would reflect clean sharp images. The instrument used was an Abbé refractometer which was kept at 25°C by circulating water while the determinations were being made. An immersion oil of index 1.65 was the medium used between the specimen and the prism of the refractometer.

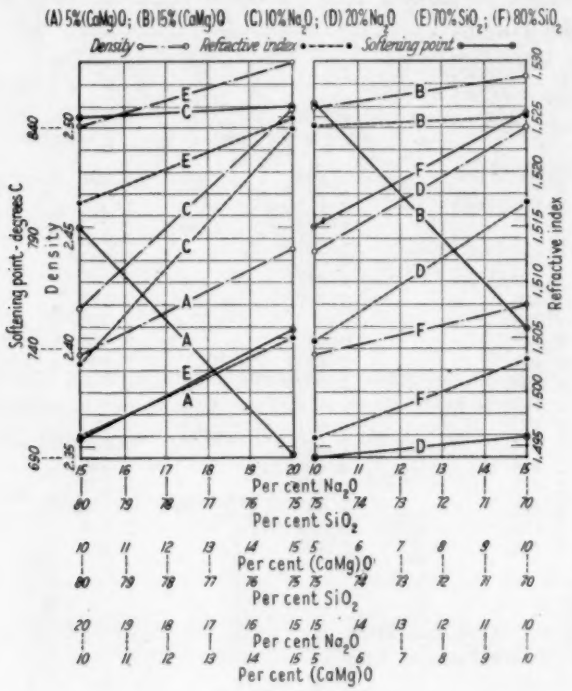

FIG. 2.

The values obtained in the duplicates did not agree as well as was desired. A possible explanation is that the index of the glass from various parts of the same batch may be variable, and as the pieces selected for the determination were not picked from any one portion of a crucible the variation might be caused in this fashion. A piece from the top and one from the bottom of crucible 1A were tested giving the values 1.4962 and 1.4952 or a difference of 0.0010. The values of the pieces originally used in 1A and 1B were 1.4953 and 1.4965. This would indicate that differences of this order between the duplicates could readily be caused by differences in location in the crucible of the specimens used for the test.

Relation of Composition and Physical Properties

The following graphs, Figs. 2 to 5, inclusive, show the effects of variation of the components on the physical properties.

Tables IV, V, and VI which follow, contain the results of the above graphs in table form.

TABLE IV

With silica constant at	70%	73%	75%	77%	80%
Softening point rises per 1% increase in "lime"	10°C	9°C	13°C	14°C	11°C
Density increases per 1% increase in "lime"	0.004	0.004	0.004	0.004	0.007
Refractive index increases per 1% increase of "lime"	0.0015	0.0018	0.0010	0.0018	0.0014

TABLE V

With "lime" constant at	5%	8%	10%	12%	15%*
Softening point falls per 1% increase in soda	21°C	17°C	15°C	12°C	18°C
Density increases per 1% increase in soda	0.010	0.007	0.007	0.008	0.003
Refractive index increases per 1% increase in soda	0.0018	0.0013	0.0014	0.0015	0.0002

* Data questionable and irregular.

TABLE VI

With soda constant at	10%	13%	15%	17%	20%
Softening point constant within limits of error					
Density increases per 1% increase in "lime"	0.016	0.010	0.012	0.012	0.011
Refractive index increases per 1% increase in "lime"	0.0042	0.0031	0.0029	0.0034	0.0025

Discussion

Certain irregularities in the softening point curves, particularly those on batches containing constant percentages of soda, suggested the theory presented in what follows as being a more acceptable interpretation than the previously given conclusions. Feild and Royster[3] have shown that the viscosity curves of melts at a temperature above the liquidus surface in the system lime–alumina–silica had discontinuities or breaks directly corresponding to those of the liquidus surface, particularly when the temperatures were not far above those of the liquidus surface.

Some such phenomenon might be the explanation for the anomalies observed in the softening point curves. Accordingly, the batches were located on the lime-soda-silica diagram as given by Morey and Bowen.[4] As the glasses all contained MgO and CaO in dolomite ratio, it was not anticipated that the diagram would exactly fit the case but would serve as a guide in interpreting the softening point (viscosity) data with the aid of the thermochemical equilibrium data.

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[3] Bur. Mines, *Tech. Paper*, No. 189.

[4] *Jour. Soc. Glass Tech.*, 9, [35], 226–64 (1925).

The softening point curves were redrawn (dotted lines on diagrams) to conform approximately to the shape of the liquidus surface of the equilibrium diagram.

Check on Graph It was found that by changing the position of the boundary lines as shown on the triaxial diagram of the system (Fig. 6) by broken lines, the softening point data as obtained fit the liquidus surface very closely, almost unexpectedly so. In view of the pres-

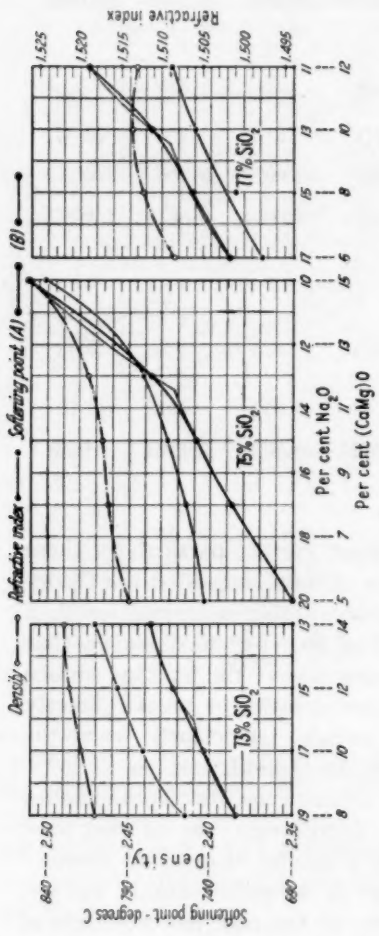

FIG. 3.

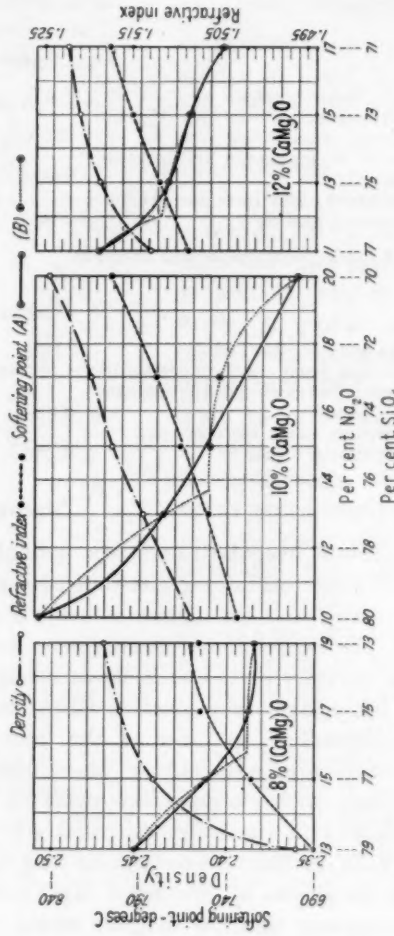

FIG. 4.

ence of MgO along with CaO and also of from 2 to 3% R_2O_3 in the glass melts such a shifting of the boundary line does not seem unreasonable.

This interpretation is interesting as it shows the probability of a close relation between the iso-softening point (viscosity) surface and the liquidus

surface of glasses which are undercooled several hundred degrees below the liquidus surface.

Chemical Analysis

After the work on physical properties was completed a chemical analysis was made of five melts in the study. The analyses were made according to the standard method of the AMERICAN CERAMIC SOCIETY.[5]

A tabulation of the results, together with the calculated oxide composition, is given in Table VII.

Batches 2, 9, and 13 were analyzed because of their irregularities in the physical tests; No. 2 was hard to work and was scummed when removed from the furnace; after melting, Nos. 13 and 19 had pronounced irregularities in density and refractive index values.

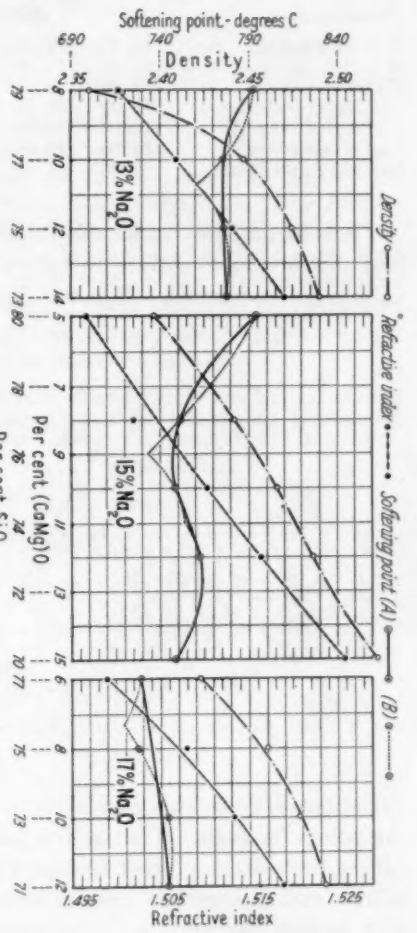

FIG. 5.

The outstanding feature of the results is the large loss of soda (determined by difference) in all of the batches and the pronounced tendency to exhibit this phenomenon increasingly toward the high soda line. This may be partly accounted for by assuming volatilization of the soda, particularly in the case of Nos. 5 and 13, which are high in soda. Another explanation is that the crucibles which were fairly porous initially but which became very dense and glassy during the melting may have taken up a considerable proportion of soda. The scum on batch 2 may have accounted for the high loss of soda in this case, as high silica glasses (80% or more) in which the ratio of the per cent of lime to the per

[5] *Jour. Amer. Ceram. Soc.*, **11** [6], 364–68 (1928).

cent of soda is in excess of 1:1 seem to form a scum on the surface of the glass. "This scum is not simply a silicate of lime but a compound of silicate of lime and soda."[6]

It might well be added that all the batches analyzed, except Nos. 5 and 19, showed irregularities in melting behavior or in physical properties.

TABLE VII

Batch number	2A	5A	9A	9B	13A	13B	19A
SiO_2 (calculated)	80.00	70.00	77.00	77.00	75.00	75.00	75.00
SiO_2 (found)	81.13	71.80	77.96	78.00	74.33	73.92	74.61
R_2O_3 (found)	2.10	3.47	1.54	1.65	2.36	2.35	1.72
(Ca,Mg)O (calculated)	10.00	10.00	12.00	12.00	8.00	8.00	10.00
(Ca,Mg)O (found)	10.97	9.74	12.05	12.06	8.17	8.43	10.14
Na_2O (calculated)	10.00	20.00	11.00	11.00	17.00	17.00	15.00
Na_2O (by difference)	5.80	14.99	8.45	8.29	15.14	15.30	13.53

These departures from the calculated values on the part of at least four of the glasses vitiate the physical measurements, so far as absolute values are concerned. But the data obtained are still valuable in our estimation as indicating the trend of change of physical properties with composition. With the exception of these unusual batches, moreover, regular changes in properties were observed, which seem to justify the assignment of numerical values.

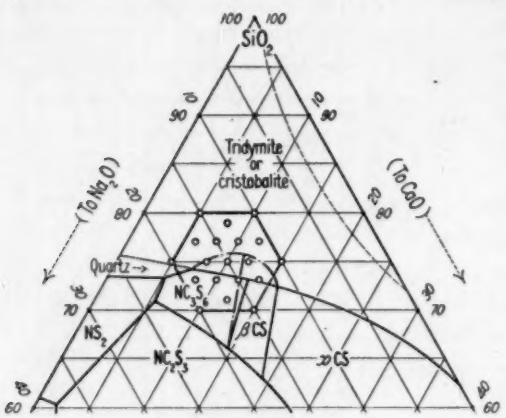

FIG. 6.

Suggested Continuance of Study

A further and valuable contribution to this study of the softening point variations of soda-lime glasses could be made by determining two softening points for each. That is, one point could be determined as was done, calling the softening point that at which the glass rod elongated 1 mm. per minute and then getting another softening point at which the rod elongated 5 or 10 mm. per minute. This should give a valuable idea of the extent of the working range of the glasses studied.

A study of the softening points of batches intermediate between certain of those in this study might shed valuable light on the theory that the softening temperatures are closely related to the liquidus surface of

[6] Gelstharp and Parkinson, *Trans. Amer. Ceram. Soc.*, **16**, 109 (1914).

the thermochemical equilibrium diagram of the system composed of glass-forming oxides.

In view of the absence of a diagram using dolomitic lime, soda, and silica, it would be advisable for this study to use high calcium lime, run all determinations on such elementary soda-lime glasses, and then check up with the equilibrium diagram as given by Morey and Bowen.[4]

Summary

(1) When soda is kept constant, a variation of "lime" and silica has little effect on the softening point. This result has a direct bearing on factory practice.

(2) Softening temperatures are controlled largely by soda, while density and refractive index are controlled by "lime."

(3) With increase in total bases the refractive index and density increase approximately in direct proportion, thus supporting the common theory regarding the influence of bases on the properties of glass.

(4) The softening temperatures of the glasses studied bear a striking relation to the temperature values indicated in the thermochemical equilibrium diagram of Morey and Bowen. These softening temperatures are approximately commercial working temperatures and this relationship indicates the possibility of application to industrial problems.

Acknowledgment The writers wish to thank A. S. Watts, Ohio State University, and S. R. Scholes, Fostoria Glass Company, Moundsville, W. Va., for their helpful coöperation and advice in this work and in the preparation of the manuscript.

INVESTIGATION OF FELDSPAR AND ITS EFFECT IN POTTERY BODIES*

By R. F. Geller and A. S. Creamer

ABSTRACT

The history and purpose of the investigation are outlined and reports are made on (1) fineness determinations, chemical analyses, softening range, softening points, "true" specific gravity, thermal expansion, and petrographic analyses of the individual feldspars; (2) the results of porosity, volume shrinkage during firing, color and translucency, mechanical strength, petrographic analyses, effect of feldspar used on relative "glaze fit," thermal expansion, and elasticity determinations on vitreous and semi-vitreous bodies in which feldspar is the only variable component.

I. Introduction

A study of all raw materials entering into the manufacture of whiteware bodies, of which this investigation of feldspar is a part, was started by the Bureau of Standards in 1922. The immediate purpose was to determine the properties of the commercial raw materials and their relation to the properties of the product. The ultimate purpose was the development of better products through a better understanding of the fundamental properties of the raw materials and of the reactions involved in the manufacture of whiteware bodies. It has been found that difficulties arise in manufacture which cannot be traced to the process of manufacture and are believed to be due to a need of better control of the materials used. The first phase of the work covered a study of whiting,[1] the second of ball clay,[2] and the third of flint.[3] The study of feldspars was started in 1924 in coöperation with a Special Committee on Feldspar of the White Ware Division of the American Ceramic Society and two progress reports were published.[4]

Feldspars are a group of minerals having similar but not identical composition. They consist essentially of alumina, silica, and the oxides of either one or more of the following metals: potassium, sodium, and calcium. While estimated to constitute nearly 60% of igneous rocks throughout the United States and Canada and among the most abundant of all minerals, they are so often intimately mixed with other minerals that their recovery in the pure state is expensive if not impossible. The chief sources of our domestic supply are the deposits in Maine, New Hampshire, Connecticut, New York, Pennsylvania, Maryland, North and South Carolina, Virginia, South Dakota, California, Nevada, and Colorado.

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* Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce. Received August 27, 1930.

[1] *Jour. Amer. Ceram. Soc.*, **5** [12], 901 (1922).

[2] Bur. Stand., *Tech. Paper*, No. 227; *Jour. Amer. Ceram. Soc.*, **7** [2], 75 (1924).

[3] Bur. Stand., *Tech. Paper*, No. 310.

[4] *The Ceramist*, p. 708 (Sept., 1925); *Jour. Amer. Ceram. Soc.*, **10** [6], 411 (1927).

Commercial feldspars vary in composition for they are frequently mixtures of several varieties of feldspars. They often contain mica, free silica or quartz, iron oxide, and other impurities in small amounts. Their variable composition may affect the physical properties and firing behavior of the ceramic product in which they are used. "Hard" (or potash) feldspars, and "soft" (or soda) feldspars have materially different softening ranges, while free silica may change the softening range of either potash or soda feldspars or mixtures of the two. The greatest use of feldspar is as a flux in the ceramic industry where it is used in the manufacture of abrasives, floor tile, terra cotta, china, and earthenware of all types. It is also used in the manufacture of glass and enamels.

II. Outline of Investigation

The investigation as originally outlined was divided into two parts as follows:

Part I. Determinations to be made on each feldspar.

(1) Fineness of grinding, to be determined both with sieves and by air elutriation.[5]
(2) Chemical analyses.
(3) Softening range.
(4) Softening point expressed in terms of pyrometric cone equivalent.
(5) "True" specific gravity: (*a*) as received and (*b*) after partial and complete fusion.
(6) Thermal expansion after partial and complete fusion.
(7) Petrographic analysis.

Part II. Comparative Behavior of the Different Feldspars in Vitreous and Semivitreous Bodies.

(1) Firing behavior and maturing range, as evidenced by porosity and volume shrinkage.
(2) Color and translucency.
(3) Mechanical strength.
(4) Composition, as determined by petrographic means.
(5) Effect of feldspar used on relative "glaze fit."
(6) Thermal expansion.
(7) Elasticity.

III. Materials Used

The nineteen samples of feldspar used in this study were obtained for the Bureau (with two exceptions) from the users by the Chairman of the Special Feldspar Committee of the White Wares Division of the AMERICAN CERAMIC SOCIETY. The trade name of the feldspar, location of the mine, and the name of the producer are listed in Table 1*A*. For obvious reasons they are not given in the same order as in the other tables in which the feldspars are given key numbers.

[5] Bur. Stand., *Tech. Paper*, No. 48.

TABLE I*A*

CLAYS AND FELDSPARS USED IN INVESTIGATION

Trade Name	Location of Mines	Produced by
Minpro No. 1	Mitchell Co., N. C.	Tennessee Mineral Products Co.
"42"	Mitchell Co., N. C.	Golding and Sons
Madoc	Hastings, Ont.	Pennsylvania Pulverizing Co.
Canadian No. 1	Near Quebec	R. L. Cawood Co.
"45"	Cecil Co., Md.	Golding and Sons
Maryland	Carroll Co., Md.	Seaboard Feldspar Co.
Keene	Cheshire Co., N. H.	Golding-Keene Co.
	St. Lawrence Co., N. Y.	Green Hill Mining Co.
R. Sant	Mitchell Co., N. C.	Erwin Feldspar Co.
"54"	Cecil Co., Md., and Mitchell Co., N. C.	Golding and Sons
Derry	Buckingham, Quebec	Dominion Feldspar Corporation
"27"	Georgetown, Me.	Golding and Sons
	Lincoln Co., Me.	Cummins Feldspar Co.
Virginia	Bedford Co., Va.	Seaboard Feldspar Co.
Glaze	Gildersleeve, Conn.	Eureka Flint & Spar Co.
No. 1	Mitchell Co., N. C.	Clinchfield Products Co.
Canadian No. 1	Balderson, Ont.	Rock Products Co.
Puritan	Cheshire Co., N. H.	Golding-Keene Co.
Maine	Topsham and Auburn, Me.	Maine Feldspar Co.

The domestic ball clay, known as Tennessee ball clay No. 5, and the North Carolina kaolin were both obtained in 1926 from the Chas. M. Franzheim Co. The Florida kaolin was received from the Florida China Clay Co. in 1923. The English ball clay (Dorset) and china clay were furnished by the Paper Makers Importing Co. (see Table I*B*). The

TABLE I*B*

CHEMICAL COMPOSITIONS OF CLAYS (IN PER CENT)

	English Ball Clay (Dorset) (1)	Ball Clay (Tenn. No. 5) (2)	Fla. Kaolin (3)	N. C. Kaolin (4)	English China Clay (5)
Ignition loss	17.2	12.4	15.3	15.9	12.6
SiO_2	44.4	56.7	44.6	46.1	46.3
Al_2O_3	33.6	25.8	38.2	34.9	38.4
Fe_2O_3	1.28	1.1	0.79	0.8	0.86
TiO_2	0.8	1.6	0.8	0.1	0.2
CaO	0.3	0.2	0.3	0.2	0.1
MgO	0.5	0.5	0.3	0.1	0.5

THERMAL EXPANSIONS OF CLAYS (IN PER CENT)

(1)		(2)		(3)		(4)		(5)	
°C	Exp.	°C	Exp.	°C	Exp.	°C	Exp.	°C	Exp.
109	0.037	109	0.053	118	0.095	134	0.037	110	0.033
212	0.083	212	0.133	202	0.199	205	0.070	198	0.080
303	0.126	303	0.188	303	0.260	289	0.114	281	0.119
393	0.171	393	0.243	383	0.307	386	0.161	385	0.165
476	0.210	476	0.297	479	0.371	477	0.196	465	0.203
526	0.234	526	0.338	537	0.406	523	0.219	524	0.226
589	0.268	589	0.405	591	0.445	588	0.267	583	0.257
701	0.334	701	0.467	696	0.506	694	0.323	685	0.311
800	0.399	800	0.513	789	0.564	792	0.373	784	0.366
881	0.451	881	0.545	892	0.612	887	0.401	897	0.415
993	0.511	993	0.592	998	0.664	995	0.470	998	0.464

flint was furnished by the National Silica Co. in 1925 and the whiting (English potter's) was obtained from Roessler & Hasslacher Chemical Co. in 1923.

IV. Part 1. Properties of Feldspars

(1) Fineness

(a) Sieve Analyses The sieve analyses were made at the Bureau and at four coöperating industrial laboratories.[6] The methods followed are abstracted from the reports of the coöperating laboratories:

Laboratory 1: "Standard screen scale laboratory sieves Nos. 100, 140, 200, and 270 were used and the analyses made according to the method given in the recommended feldspar specifications of the AMERICAN CERAMIC SOCIETY."[7]

Laboratory 2 (Bureau of Standards): United States standard sieves Nos. 100, 200, 270, and 325, calibrated according to the U. S. Standard Sieve Series, were used. A 100-gram sample was placed on the No. 325 sieve and washed gently without brush until the fines were removed. The sieves were then stacked and the residue transferred to the top sieve (No. 100) and the material washed on each sieve over the remainder of the stack, a soft brush being used to break down aggregates. The residues were then dried on the sieves and the regular method of dry sieving used, after which both the final residue on each sieve and the fines removed by the dry sieving were weighed. The results given under A (Table II) are the sum of the final residues and the fines (equivalent to wet sieving alone) and the results given under B are those obtained by the combined wet and dry sieving. While the B method is advocated, the results are not considered in the averages since the method was not used by any of the coöperating laboratories.

Laboratory 3: "100-gram samples were washed through a No. 325 sieve to remove the very fine material. The residue on the sieve was then washed through the following series of sieves: 100-mesh, 120-mesh, 150-mesh, 200-mesh, 270-mesh, and 325-mesh. After thorough washing the residues are dried at 110°C and then weighed." The results given in Table II are the averages of two determinations.

Laboratory 4: Sieves Nos. 100, 150, 200, 250, and 325 were used. The method used was described as follows:

> Weigh out a sample of 250 grams, blunge for ten or fifteen minutes by means of a small motor-driven stirrer, then wash this slip through the several screens with the aid of a jet of water delivered through a rubber tube. In this way very little brush work is necessary.

Laboratory 5: Tyler screens Nos. 100, 140, 200, 250, 300, and 325 were used. The method used was described as follows:

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[6] General Electric Co. (Schenectady, N. Y.); A C Spark Plug Co. (Flint, Mich.); Western Electric Co. (Hawthorne Station, Chicago); and the Onondaga Pottery Co. (Syracuse, N. Y.).

[7] *Jour. Amer. Ceram. Soc.*, **6** [6], 165 (1923).

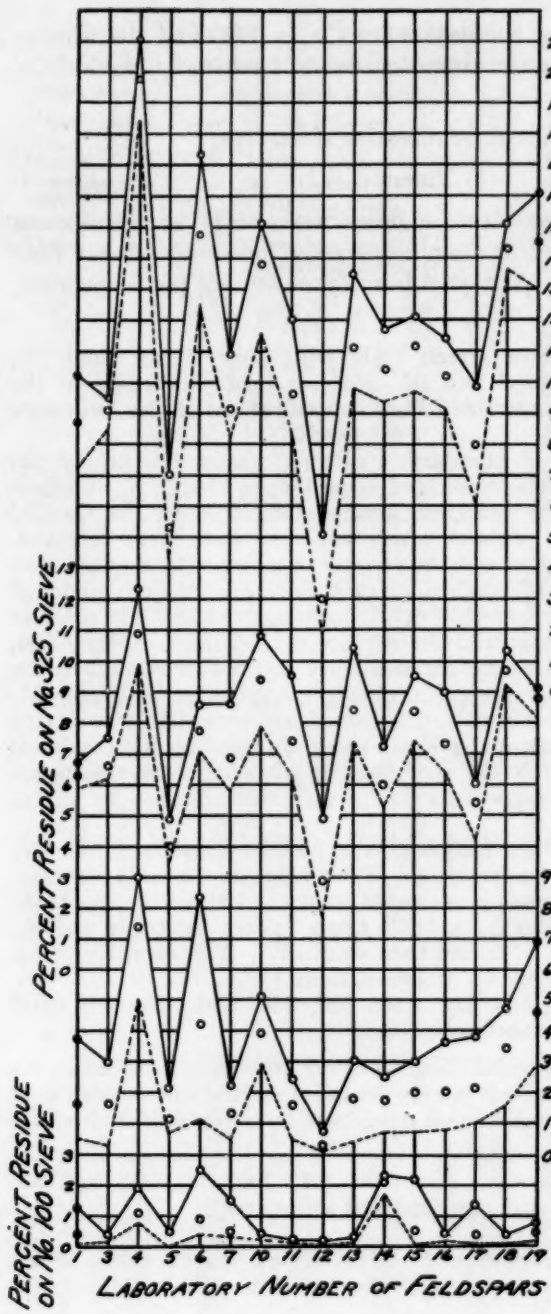
PERCENT TOTAL RESIDUE ON No. 325 SIEVE
PERCENT RESIDUE ON No. 325 SIEVE
PERCENT RESIDUE ON No. 200 SIEVE
PERCENT RESIDUE ON No. 100 SIEVE
LABORATORY NUMBER OF FELDSPARS

FIG. 1.—Values plotted to show variations in fineness determinations as obtained by five laboratories working independently but on portions of the same samples. Maximum, minimum, and average values are plotted in the figure.

We followed as far as possible the method of testing as outlined in the pamphlet;[4] however, we used a separate sample for each screen.

Although the determinations by the five laboratories were made on carefully prepared portions of the same samples, it is realized that they are not directly comparable since different methods were followed, sieves of the same number were not used throughout, and the calibration of the sieves used by the coöperating laboratories is not known. They do show the variation, however, in results actually obtained on the same material by five laboratories, any one of which would probably consider its results

as reliable. Sieves Nos. 100, 200, and 325 were used in practically every instance (Lab. No. 1 did not use sieve No. 325) and therefore the results were calculated to residues on these three sieves and are presented in Table II. It is interesting to note that the data as originally submitted by one laboratory were given to the nearest 0.001% and by two laboratories to the nearest 0.01%. It is quite evident from the data in Table II that a fineness requirement even to 0.5% would have little significance in a general specification. For convenience the range of variations is shown graphically in Fig. 1. (Values obtained by B method, Lab. 2, are not plotted. Since complete data were not available for feldspars Nos. 2, 8, and 9, these also are omitted in the figure.)

The average residue on the No. 100 sieve (Fig. 1) varied from 0.0 to 2.1% (feldspars 12 and 14) and the final average was 0.4%. Only two samples (Nos. 4 and 14) showed a residue of over 1.0%. The maximum variation between laboratories on individual samples was 2.1% (No. 6) and the average variation for all the samples was 0.7%.

The average residue on the No. 200 sieve varied from 0.3 to 7.4% (feldspars 12 and 4) and the final average was 2.4%. Only 5 out of 19 samples showed a residue of more than 2.0%. The maximum variation between results obtained by different laboratories on individual samples was 7.2% (No. 6) and the average variation for all the samples was 2.6%.

The average residue on the No. 325 sieve (average for Laboratories 2, 3, and 4 only, Fig. 1) varied from 2.9 to 10.9% (Nos. 12 and 4) and the final average for all the samples (Laboratories 2, 3, and 4 only) was 7.3%. The maximum variation between results obtained by the three laboratories on individual samples was 3.2% (Nos. 11 and 12) and the average variation for all the samples (Fig. 1) was 2.1%. That the average variation for sieve No. 325 did not exceed that for sieve No. 200 (as might be expected) is due to the elimination of results from Lab. No. 5 where, as previously noted, a method differing radically from that of the others was used and which produced results generally varying most from the average.

(b) By Air Elutriation Pressler and Shearer[8] found practically the same order of fineness for potters' flint whether determined by the 0.02 and 0.04 mm. separations (made by air elutriation) or by sieve tests. This was not found when testing the feldspars. The extremes of fineness according to residues on the No. 325 sieve (feldspars 12 and 4) do not correspond to the extremes either according to the 0.04 mm. separation (feldspars 11 and 17) or the 0.02 mm. separation (feldspars 15 and 17). The nineteen samples can be divided into fairly well-defined groups according to fineness, as in Table III.

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[8] Bur. Stand., *Tech. Paper*, No. 310, p. 295; see also reference in paper by Schramm and Scripture, *Jour. Amer. Ceram. Soc.*, **10** [4], 264–67 (1927).

TABLE II

RESULTS OF FINENESS DETERMINATIONS USING SIEVE METHOD

Lab. No.	% Residue on Sieve No. 100	200	325	Total on Sieve 325
Feldspar No. 1 (7)				
1	0.2	0.9		
2A	0.2	1.1	5.9	7.2
B	0.1	1.0	3.9	5.0
3	0.1	3.7	6.4	10.2
4	0.4	1.7	6.7	8.8
5	1.3	0.5		
Av.	0.4	1.6	6.3	8.7
Per cent greater than 0.04 mm. 20.5				
Per cent greater than 0.02 mm. 38.2				
Feldspar No. 2 (18)				
2A	0.1	2.1	6.8	9.0
B	0.0	1.9	5.4	7.3
Per cent greater than 0.04 mm. 27.1				
Per cent greater than 0.02 mm. 47.9				
Feldspar No. 3 (11)				
1	0.2	0.3		
2A	0.2	2.1	6.2	8.5
B	0.2	1.9	5.3	7.4
3	0.2	3.0	6.2	9.4
4	0.4	1.6	7.5	9.5
5	0.4	0.8		
Av.	0.3	1.6	6.6	9.1
Per cent greater than 0.04 mm. 22.0				
Per cent greater than 0.02 mm. 45.1				
Feldspar No. 4 (5)				
1	0.8	8.2		
2A	0.8	7.2	10.4	18.4
B	0.7	6.6	8.3	15.6
3	1.0	9.0	9.9	19.9
4	1.2	7.6	12.3	21.1
5	1.9	5.0		
Av.	1.1	7.4	10.9	19.8
Per cent greater than 0.04 mm. 32.7				
Per cent greater than 0.02 mm. 53.6				
Feldspar No. 5 (4)				
1	0.0	0.9		
2A	0.0	0.9	3.7	4.6
B	0.0	0.7	2.7	3.1
	(0.0)	(1.2)	(2.6)	(3.8)
3	0.0	2.1	4.9	7.0
4	0.1	0.7	3.5	4.3
5	0.5	1.0		
Av.	0.1	1.1	4.0	5.3
Per cent greater than 0.04 mm. 18.8				
Per cent greater than 0.02 mm. 38.3				

Lab. No.	% Residue on Sieve No. 100	200	325	Total on Sieve 325
Feldspar No. 6 (8)				
1	0.7	2.2		
2A	0.5	4.5	7.5	12.5
B	0.5	4.2	6.0	10.7
3	0.5	8.3	8.6	17.4
4	2.5	5.0	7.1	14.6
5	0.4	1.1		
Av.	0.9	4.2	7.7	14.8
Per cent greater than 0.04 mm. 23.1				
Per cent greater than 0.02 mm. 39.1				
Feldspar No. 7 (16)				
1	0.3	0.5		
2A	0.3	1.7	6.2	8.2
B	0.3	1.5	4.1	5.9
3	0.3	2.2	5.8	8.3
4	0.4	1.9	8.6	10.9
5	1.5	0.5		
Av.	0.5	1.3	6.9	9.1
Per cent greater than 0.04 mm. 23.5				
Per cent greater than 0.02 mm. 40.7				
Feldspar No. 8 (17)				
1	0.1	0.5		
2A	0.1	2.5	8.1	10.7
B	0.1	1.9	6.2	8.2
Av.	0.1	1.5	8.1	10.7
Per cent greater than 0.04 mm. 27.9				
Per cent greater than 0.02 mm. 52.1				
Feldspar No. 9 (19)				
2A	0.1	1.4	5.3	6.8
B	0.1	1.2	3.9	5.2
Per cent greater than 0.04 mm. 23.3				
Per cent greater than 0.02 mm. 40.1				
Feldspar No. 10 (1)				
1	0.3	4.1		
2A	0.2	3.6	7.8	11.6
B	0.2	3.3	6.7	10.2
	(0.2)	(4.7)	(6.1)	(11.0)
3	0.2	5.1	9.5	14.8
4	0.4	3.9	10.8	15.1
5	0.4	2.9		
Av.	0.3	3.9	9.4	13.8
Per cent greater than 0.04 mm. 27.6				
Per cent greater than 0.02 mm. 48.8				

TABLE II (*concluded*)

Lab. No.	% Residue on Sieve No. 100	200	325	Total on Sieve 325
Feldspar No. 11 (14)				
1	0.1	1.2		
2A	0.1	1.8	6.4	8.3
B	0.1	1.6	5.0	6.7
3	0.1	2.2	6.3	8.6
4	0.1	2.4	9.5	12.0
5	0.2	0.5		
Av.	0.1	1.6	7.4	9.6
Feldspar No. 12 (15)				
1	0.0	0.3		
2A	0.0	0.2	2.0	2.2
B	0.0	0.1	0.9	1.0
	(0.0)	(0.2)	(1.0)	(1.2)
3	0.0	0.1	1.7	1.8
4	0.0	0.2	4.9	5.1
5	0.2	0.7		
Av.	0.0	0.3	2.9	3.0
Per cent greater than 0.04 mm. 21.6				
Per cent greater than 0.02 mm. 47.9				
Feldspar No. 13 (13)				
1	0.1	1.2		
2A	0.1	2.2	7.5	9.8
B	0.1	1.9	4.8	6.8
3	0.1	2.5	7.4	10.0
4	0.1	3.0	10.4	13.5
5	0.3	0.4		
Av.	0.1	1.8	8.4	11.1
Per cent greater than 0.04 mm. 25.3				
Per cent greater than 0.02 mm. 49.1				
Feldspar No. 14 (10)				
1	1.7	0.7		
2A	2.1	2.0	5.3	9.4
B	2.0	1.8	4.0	7.8
3	2.2	2.5	5.5	10.2
4	2.3	2.2	7.2	11.7
5	2.1	1.1		
Av.	2.1	1.7	6.0	10.4
Feldspar No. 15 (2)				
1	0.2	1.5		
2A	0.1	2.2	7.4	9.7
B	0.1	2.0	6.4	8.5
3	0.1	3.0	8.3	11.4
4	0.1	2.5	9.5	12.1
5	2.2	0.7		
Av.	0.5	2.0	8.4	11.1

Lab. No.	% Residue on Sieve No. 100	200	325	Total on Sieve 325
Feldspar No. 16 (9)				
1	0.2	0.8		
2A	0.2	2.4	6.5	9.1
B	0.1	2.0	5.0	7.1
3	0.2	3.6	6.4	10.2
4	0.3	2.1	9.0	11.4
5	0.4	1.0		
Av.	0.3	2.0	7.3	10.2
Feldspar No. 17 (6)				
1	0.2	2.0		
2A	0.1	1.8	4.2	6.1
B	0.1	1.8	3.8	5.7
3	0.1	3.8	6.0	9.9
4	0.3	1.9	5.9	8.1
5	1.4	1.0		
Av.	0.4	2.1	5.4	8.0
Per cent greater than 0.04 mm. 17.0				
Per cent greater than 0.02 mm. 32.4				
Feldspar No. 18 (12)				
1	0.1	2.1		
2A	0.1	3.8	9.7	13.6
B	0.1	3.5	6.6	10.2
3	0.1	4.7	9.2	14.0
4	0.2	4.7	10.3	15.2
5	0.4	1.6		
Av.	0.2	3.4	9.7	14.3
Per cent greater than 0.04 mm. 28.6				
Per cent greater than 0.02 mm. 46.6				
Feldspar No. 19 (3)				
1	0.3	2.9		
2A	0.3	4.5	8.2	13.0
B	0.2	4.1	6.6	10.9
	(0.1)	(5.5)	(6.0)	(11.6)
3	0.2	6.9	9.0	16.1
4	0.7	4.6	9.1	14.4
5	0.8	4.3		
Av.	0.5	4.6	8.8	14.5
Per cent greater than 0.04 mm. 24.6				
Per cent greater than 0.02 mm. 42.7				

General Averages

Residue on No. 100 sieve	0.4%
Residue on No. 200 sieve	2.4%
Residue on No. 325 sieve	7.2%
Total on No. 325 sieve	10.5%
Per cent greater than 0.04 mm.	24.8
Per cent greater than 0.02 mm.	44.7

NOTE: The results reported for Lab. No. 3 are the average of two determinations.
The results under A for Lab. No. 2 (Bur. Stand.) are equivalent to results obtained by wet sieving alone (see text).
The results given under B, Lab. No. 2, were obtained by combined wet and dry sieving (see text).

The results given parenthetically under B, Lab. No. 2, in the case of feldspars Nos. 5, 10, 12, and 19 are check determinations by a second investigator at the Bureau.

The feldspars are arranged in order of increasing K_2O content and are numbered accordingly. The key numbers given parenthetically are the numbers originally assigned to the feldspars when received and are the numbers under which the feldspars were submitted to coöperating laboratories and also the numbers used by H. Insley in his report on the petrographic analyses of these feldspars (*Jour. Amer. Ceram. Soc.*, **10** [9], 651 (1927)).

TABLE III

GROUPING OF FELDSPARS ACCORDING TO FINENESS AS DETERMINED BY THE NO. 325 SIEVE AND 0.02 MM. AIR SEPARATION

Total Residue on No. 325 Sieve			0.02 Mm. Separation		
Group	Residue	Samples	Group	Residue	Samples
A	3.2–9.5% (av. 7.4)	1, 2, 3, 5, 7, 9, 12, and 17	(*a*)	32–43% (av. 39.4)	1, 5, 6, 7, 9, 14, 16, 17, and 19
B	9.6–13% (av. 10.6)	8, 11, 13, 14, 15, and 16	(*b*)	45–50% (av. 47.7)	2, 3, 10, 11, 12, 13, and 18
C	13.8–19.8% (av. 15.4)	4, 6, and 10	(*c*)	52–55% (av. 53.4)	4, 8, and 15

(2) Chemical Composition

Chemical analyses of all samples were made at the Bureau of Standards and samples Nos. 10, 15, and 19 were analyzed also by an industrial laboratory.[9] The results are given in Table IV. Values for group averages are given in Table V and some general observations in Table VI. With the exception of sample No. 1, which is a relatively pure soda feldspar, all of the feldspars tested can be considered as so-called "potash feldspars."[10]

TABLE IV

CHEMICAL COMPOSITION IN PER CENT

Feldspar No.	Analyst	Ignition loss	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O	Na_2O	$K_2O + Na_2O$	Total
	1A	0.5	67.4	20.0	0.27	t	0.5	0.2	1.0	10.0	11.0	99.9
1	B	0.5	68.2	19.2	0.39	0.0	0.7	0.3	1.3	10.0	11.3	100.6
	2	0.6	67.7	19.6	0.18	0.0	0.5	0.2	0.9	10.0	10.9	99.7
	Av.	0.5	67.8	19.6	0.28	0.0	0.6	0.2	1.1	10.0	11.1	
	1A	0.6	73.1	15.4	0.06	0.0	0.8	s.t.	4.5	5.6	10.1	100.1
2	B	0.5	74.1	14.3	0.09	0.0	0.9	0.3	4.5	5.4	9.9	100.1
	2	0.5	73.9	15.0	0.05	0.0	0.7	0.2	4.3	5.7	10.0	100.3
	Av.	0.5	73.7	14.9	0.06	0.0	0.8	0.2	4.4	5.6	10.0	
3	1A	0.6	67.4	19.4	0.16	s.t.	0.5	0.4	5.2	5.7	10.9	99.4
4	1A	0.8	70.9	17.5	0.12	s.t.	0.3	s.t.	6.4	3.9	10.3	99.9
	1A	0.6	71.8	16.1	0.15	t	0.7	t	7.0	3.5	10.5	99.8
5	B	0.6	72.2	14.6	0.18	0.0	0.8	0.4	7.8	3.4	11.2	100.0
	2	0.7	72.1	15.1	0.08	0.0	0.6	0.4	7.6	3.4	11.0	100.0
	Av.	0.6	72.0	15.3	0.14	0.0	0.7	0.3	7.5	3.3	10.9	
6	1A	0.6	70.6	16.4	0.12	0.0	0.6	0.3	7.5	3.3	10.8	99.4

[9] Champion Porcelain Co., Detroit, Mich.

[10] Purely arbitrary expression.

TABLE IV (*concluded*)

Feldspar No.	Analyst	Ignition loss	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O	Na_2O	$K_2O + Na_2O$	Total
7	1A	0.5	73.2	15.8	0.19	s.t.	0.5	s.t.	7.6	2.8	10.4	100.6
8	1A	0.7	67.8	18.4	0.37	s.t.	0.9	t	8.4	3.6	12.0	100.2
9	1A	0.4	71.1	16.1	0.09	s.t.	0.5	s.t.	9.0	3.0	12.0	100.2
	1A	0.7	67.6	18.8	0.04	0.0	0.8	s.t.	9.1	3.3	12.4	100.3
10	B	0.6	68.5	17.9	0.23	0.0	0.9	0.1	9.4	3.2	12.6	100.8
	2	0.6	67.8	18.0	0.06	0.0	0.8	0.1	9.0	3.4	12.4	99.8
	3	0.5	67.8	17.9	0.20	0.0	0.9	0.0	9.2	3.3	12.5	99.8
	Av.	0.6	67.9	18.1	0.13	0.0	0.8	0.05	9.2	3.3	12.5	
11	1A	0.3	68.7	17.9	0.16	0.0	0.5	s.t.	9.1	3.4	12.5	100.1
12	1A	0.2	68.8	18.2	0.10	0.0	0.5	s.t.	9.5	3.2	12.7	100.5
13	1A	0.3	68.7	18.1	0.17	0.0	0.2	t	9.8	3.1	12.9	100.4
14	1A	0.3	68.5	17.8	0.08	s.t.	0.2	0.1	10.1	2.6	12.7	99.7
15	1A	0.4	67.0	19.4	0.02	0.0	0.7	s.t.	10.2	2.9	13.1	100.6
	3	0.3	67.4	18.1	0.14	0.0	0.1	0.1	11.2	2.5	13.7	99.8
	Av.	0.3	67.2	18.7	0.08	0.0	0.4	0.0	10.7	2.7	13.4	
16	1A	0.3	69.1	17.7	0.09	0.0	0.3		10.5	2.5	13.0	100.5
17	1A	1.2	65.2	19.7	0.15	s.t.	0.3	s.t.	12.2	1.2	13.4	99.9
	1A	0.3	65.1	19.5	0.20	0.0	0.3	0.0	12.3	2.6	14.9	100.3
18	B	0.4	66.2	18.4	0.15	0.0	0.4	0.1	12.4	2.6	15.0	100.6
	2	0.5	65.6	18.9	0.08	0.0	0.3	0.0	12.4	2.8	15.2	100.6
	Av.	0.4	65.6	18.9	0.14	0.0	0.3	0.0	12.4	2.7	15.1	
	1A	0.2	64.9	19.6	0.08	0.0	0.3	s.t.	13.0	2.0	15.0	100.1
19	B	0.3	65.4	18.5	0.15	0.0	0.3	0.1	13.4	1.8	15.6	99.9
	2	0.4	65.3	18.9	0.05	0.0	0.2	0.0	13.2	2.1	15.3	100.1
	3	0.3	65.1	18.8	0.18	0.0	0.0	0.2	13.1	2.0	15.1	99.7
	Av.	0.3	65.2	18.9	0.11	0.0	0.2	0.1	13.2	2.0	15.2	

NOTE: Analyst No. 1, V. C. Swicker, Bur. of Stand.
Analyst No. 2, R. B. Rudy, Bur. of Stand.
Analyst No. 3, Champion Porcelain Company.
Results reported under 1A were obtained by rapid routine methods involving single evaporations and precipitations, while those reported under 1B and 2 were obtained by methods involving double evaporations and precipitations, and other precautions necessary to insure greater accuracy.
Uncombined silica calculated from the chemical composition.

TABLE V

GROUPING OF "POTASH FELDSPARS" ACCORDING TO THE PERCENTAGE CONTENT OF POTASH, SODA, TOTAL FLUX, AND UNCOMBINED SILICA USING AVERAGE VALUES WHEREVER MORE THAN ONE DETERMINATION WAS MADE

Group	Feldspars included in group	K_2O (%)	$K_2O + Na_2O$ (%)	Total "Flux" (%)	Uncombined SiO_2 (av.) (%)
D	2– 9 (inc.)	4.4– 9.0	10.1–12.0	10.6–12.9	18.6
E	10–17 (inc.)	9.1–12.2	12.4–13.4	13.0–13.8	11.0
F	18 and 19	12.3–13.1	15.0–15.1	15.3–15.4	1.0

Figure 2 shows the mineral composition of the feldspars calculated from the chemical composition using average values wherever available.

(3) Softening Range

The specimens for this test were formed by pressing dampened feldspar into a tapered mold, using the rubber tipped end of a lead pencil. The specimens when formed were $^{9}/_{16}$ inch high and $^{3}/_{4}$ inch and $^{7}/_{16}$ inch in diameter at the ends. A small amount of light machine oil was applied to the surface of the mold to facilitate removal of the specimen. Each specimen was set, large diameter down, on a small vitrified tile preparatory to firing. The specimens were fired in a secondary muffle placed in a gas-fired, recuperative, downdraft, semimuffle kiln, and the necessary precautions were taken to insure temperature uniformity and control. The kiln was usually started about 4 P.M. and allowed to heat up over night without attention. By morning the temperature had reached 900°C ± 75° and was then controlled so as to rise at approximately 20° per hour to within "2 cones" (about 50°) of the cone at which the specimens were to be fired. The temperature was then held at this point until the desired cone was down, when the tile bearing the specimens were withdrawn. A separate series of samples was made for firing at each cone and observations indicated that the temperature gradient, in the muffle, in no case exceeded $^{1}/_{2}$ cone (10 to 15°C).

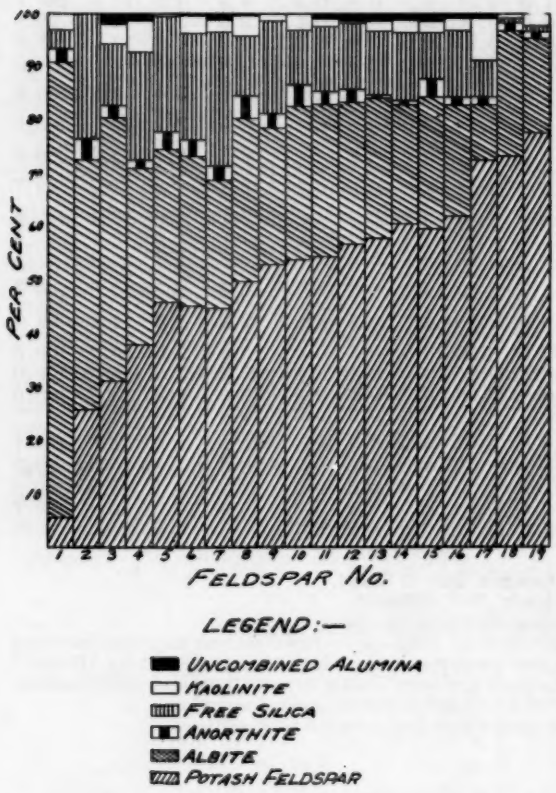

FIG. 2.—Mineral composition of the feldspars calculated from the chemical composition.

The results are illustrated in Fig. 3. Progress of softening was judged by the relative mattness of the surface, rounding of the upper edges, glossiness of the surface (indicated in the drawing by a "reflection"), "squatting" of the specimen, and finally by its fusion and flow into the

form of a "button." It is obvious that the beginning and length of the temperature deformation range are determined primarily by the K_2O–Na_2O ratio. The cone at which glossiness appears increases from cone 4, for the feldspar lowest in K_2O content (No. 1), to cone 10 for Feldspars 13 to 19, inclusive. In general, the results show that refractoriness increases, and the softening range decreases, with increase in K_2O, but that these

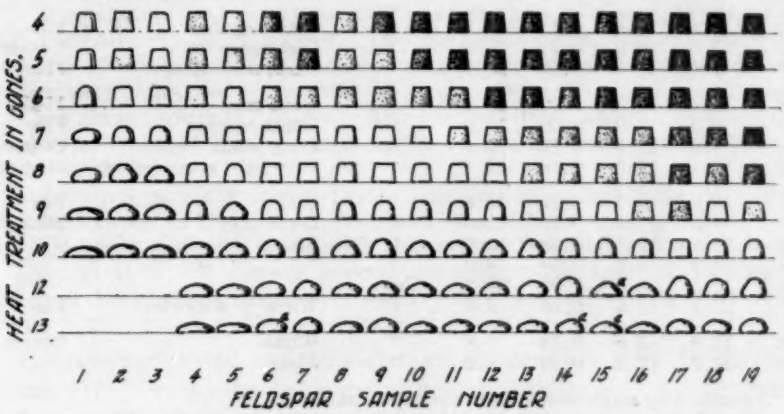

FIG. 3.—Various feldspar specimens after the so-called "button test" for determining softening range. Buttons identified by letter *a* contained many small bubbles.

relations may be influenced by Fe_2O_3 (Example No. 8) and uncombined SiO_2 (Example: Nos. 1 and 3). General properties of the samples are summarized in Table VI.

(4) Softening Points or Pyrometric Cone Equivalents

The softening points were determined with specimens of feldspar made into cones of the size and shape of large standard pyrometric cones. The "softening point" is considered as that stage in the softening range at which the cone has bent sufficiently to bring the tip on a level with the top surface of the plaque in which the cone is mounted and results are expressed in terms of Orton pyrometric cones. (Example: A "softening point" of cone 8 half-down means that the Orton standard cone No. 8 was half-down when the test cone of feldspar had reached its "softening point.") Tests were made by the Bureau and three coöperating industrial laboratories (Table VII), the numbers used to designate the laboratories being the same as used in Table II. The information available regarding details of the methods used by the coöperating laboratories is limited:

Laboratory 1: The cones were made up with dextrin water to the standard dimensions, *i.e.*, three-sided pyramids $2^7/_8$ in. high and $^9/_{16}$ in.

TABLE VI

GENERAL PROPERTIES AS RELATED TO COLOR AND SOFTENING RANGE

Feldspar No.	K_2O (%)	$K_2O + Na_2O$ (%)	Fe_2O_3 (%)	Free SiO_2[a] (%)	Softening range	Color of button	Grind[b]
1	1.1	11.1	0.28	3.8	Long	Ivory	Fine
2	4.4	10.0	0.06	23.5	Medium	White; semi-opaque	Fine
3	5.2	10.9	0.16	11.4	Long	Light gray	Fine
4	6.4	10.3	0.12	20.4	Medium	Gray; semi-opaque	Coarse
5	7.5	10.9	0.11	21.9	"	White opaque	Fine
6	7.5	10.8	0.12	20.0	"	Light gray	Coarse
7	7.6	10.4	0.19	25.1	"	Pink; semi-opaque	Fine
8	8.4	12.0	0.37	11.3	"	Dark gray	Medium
9	9.0	12.0	0.09	17.6	"	White opaque	Fine
10	9.2	12.5	0.13	10.4	"	Dirty white	Coarse
11	9.1	12.5	0.16	12.4	"	Very light gray; yellow	Medium
12	9.5	12.7	0.10	12.5	"	White	Fine
13	9.8	12.9	0.17	12.0	"	Light gray	Medium
14	10.1	12.7	0.08	12.6	"	White	"
15	10.7	13.4	0.08	8.5	"	"	"
16	10.5	13.0	0.09	12.7	Short	"	"
17	12.2	13.4	0.15	6.9	"	White to semi-clear	Fine
18	12.9	15.0	0.14	0.8	"	White	Coarse
19	13.2	15.2	0.10	1.2	"	Clear	"

[a] Obtained by recalculation from chemical analyses.

[b] Classified from data in Table III as follows: Residue on No. 325 sieve: fine, 3.2–9.5%; medium, 9.6–13.0%; and coarse, 13.8–19.8%.

TABLE VII

SOFTENING POINTS

(All values given in terms of Orton standard pyrometric cone numbers)

	Laboratory No.						
	1	2		4	5		
Feldspar No.		First test	Second test			Variation (total)	Average softening point
1	5 hd	4 hd	4 hd	5	3	$2^1/_2$	4
2		5	5				(5)
3	5	4	4 hd	4	3	2	4
4	6	6 hd	6 hd	6	6	$^1/_2$	6
5	6 hd	6 hd	6 hd	5	6	$^1/_2$	6 hd
6	7 hd	7 hd	7 hd	7	6	1	7 hd
7	7 hd	8 hd	7	8	7	$1^1/_2$	7
8	6 hd	6 hd	5			$^1/_2$	6 hd
9		7	7				(7)
10	7 hd	7 hd	7 hd	6	7	1	7 hd
11	7 hd	7 hd	7 hd	7	6	1	7 hd
12	7 hd	7	7 hd	8	5	3	7
13	9 hd	8 hd	7	8	7	$1^1/_2$	8
14	8 hd	8 hd	8 hd	8	7	1	8 hd
15	8	8	8	10 hd	8	$1^1/_2$	8
16	9 hd	8 hd	8 hd	9	7	2	8
17	9	10 hd	10 hd	10 hd	9	$^1/_2$	10 hd
18	8	8 hd	8	8	8	$^1/_2$	8
19	9	9 hd	9	10 hd	9	1	9
					Av. variation	$1^1/_2$	

hd = half-down (all values given to the nearest half cone).

across the base of each face. The cone deformation was studied and interpreted in terms of standard Orton cones as they advanced into a gas-fired tunnel kiln at the rate of 200°C per hour.

Laboratory 2 (Bureau of Standards): The cones were formed in plaster molds, using the feldspar dampened with a dilute solution of dextrin. Preliminary runs were made in a gas-fired furnace to determine the approximate softening point of each feldspar and the final tests were conducted with the same furnace "set-up" as described under "Softening Range." The temperature was raised to 1000°C at the rate of about 50° per hour and thereafter at 20° per hour. The plaques, bearing the feldspar cones and the standard cones nearest in softening point as determined by the preliminary runs, were removed from the muffle as the feldspar cones reached their "softening point." The temperatures, under the conditions of this test, ranged from approximately 1150°C for cone 3 to 1250°C for cone 10 half-down.

Laboratory 4: The fusion points reported were determined by firing standard cones of the various feldspars in a surface combustion furnace, provided with a muffle, along with the appropriate standard cones.

Laboratory 5: We made several softening point tests under slightly different conditions, the results of which check very well among themselves.

The results reported and the variations obtained are given in detail in Table VII. Considering the widely different methods used, the agreement is very good.

(5) "True" Specific Gravity

"True" specific gravity is tentatively defined by the AMERICAN CERAMIC SOCIETY[11] as "the weight per unit volume of the solid material in which all sealed pores or cavities and all water-permeable pores have been obliterated by fine grinding."

The samples for specific gravity determinations were prepared by crushing between hardened steel surfaces, grinding them in an agate mortar to pass a No. 100 sieve, removing all magnetic materials and drying at 110°C according to the method recommended in Standard Methods of the AMERICAN CERAMIC SOCIETY.[12] Weighings were made to the fourth decimal and the amount used for each determination varied from approximately five to eight grams. Duplicate determinations were made and unless the values checked within ± 0.0025 they were discarded and the determinations repeated.

Hubbard type picnometers with slight modifications were used for the specific gravity determinations of the partly fused feldspars. The stopper was reground and a glass disk and its seat were carefully polished to seal the capillary and prevent evaporation. The picnometer was dried at 110°C, cooled, and weighed. The sample was introduced, weighed, and

[11] *Jour. Amer. Ceram. Soc.*, **11** [6], 349 (1928).

[12] *Jour. Amer. Ceram. Soc.*, **11** [6], 456–57 (1928).

placed under a bell jar. The pressure in the bell jar was reduced and then distilled water, freshly boiled, sufficient to cover the sample was added carefully through a separatory funnel. The vacuum pump operated while the water was being added. The picnometer was then removed, more water added, and the sample allowed to settle. After this, the picnometer was completely filled with water, cooled to 20°C ± 0.1° in a constant temperature water bath, wiped dry with a soft, clean cloth, and weighed at 20°C or lower.

The specific gravities of the raw feldspars also were determined by the water-displacement method, but were brought to a temperature of 30°C in the constant temperature bath before weighing. The picnometers used were of the narrow neck bulb type modified in that the stem of the ground stopper carried a glass stop-cock and bulb. After the picnometer, water, and sample had come to equilibrium in the bath, the stopper was closed and the excess water removed. Since the temperature of the balance

TABLE VIII

"TRUE" SPECIFIC GRAVITY OF FELDSPAR

	Raw Feldspar		Feldspar Fired to					
Feldspar No.	(a) 30°C / 30°C	(b) 30°C / 20°C	Cone 4 20°C / 20°C	Cone 8 20°C / 20°C	Cone 10 20°C / 20°C	Cone 12 20°C / 20°C	Cone 13 20°C / 20°C	Cone 14 20°C / 20°C
1	2.635	2.628	2.513	2.424	2.374			
2	2.621	2.614	2.517	2.422	2.407			
3	2.613	2.606	2.461	2.422	2.389			
4	2.619	2.612		2.428	2.420		2.413	
5	2.611	2.604		2.412	2.407		2.386	
6	2.610	2.603		2.454	2.422		2.393	
7	2.612	2.604		2.445	2.403		2.395	
8	2.593	2.586		2.404	2.397		2.388	
9	2.596	2.589		2.411	2.394		2.384	
10	2.602	2.595		2.412	2.402		2.400	
11	2.601	2.594		2.406	2.397		2.395	
12	2.599	2.592		2.408	2.403		2.377	
13	2.594	2.587		2.426	2.410	2.394		2.376
14	2.590	2.583		2.435	2.414	2.396		2.372
15	2.587	2.580		2.430	2.401	2.387		2.370
16	2.591	2.584			2.412	2.406		2.374
17	2.572	2.565			2.409	2.400		2.377
18	2.583	2.576			2.381	2.379		2.376
19	2.572	2.565			2.397	2.376		2.375

(a) Taken from the Second Progress Report, see footnote 4.
(b) Calculated from values determined with reference to water at 30°C.

room never exceeded 30°C, the water in the picnometer contracted and the stopper prevented evaporation. The values for the raw feldspars are given (Table VIII) both with reference to water at 30°C and also, for comparative purposes, as calculated with reference to water at 20°C.

The specific gravities were calculated by the formula:

$$g = \frac{w - p}{(w - p) - (w_2 - w_1)}$$

In which

g = "true" specific gravity
w = weight of picnometer (bottle, stopper, and disk) and sample
p = weight of picnometer
w_1 = weight of picnometer filled with freshly boiled distilled water (with stopper and disk in place)
w_2 = weight of picnometer, sample, and water

(a) Feldspars as Received Results are given in Table VIII, which show that the average values vary from 2.635 for Sample 1 (high soda feldspar) to 2.572 for Sample 19 (high potash feldspar). Purdy and Moore report 2.574 for the specific gravity of potash feldspar.[13] Larsen[14] reports 2.605 for the specific gravity of albite (soda feldspar) and 2.56 for orthoclase (potash feldspar). Rieke[15] gives 2.59 as the specific gravity of a potash feldspar.

Since there is a difference of only 2.4% (2.572 to 2.635) between the greatest and the least specific gravities of the 19 raw feldspars covering the field from a high soda to a high potash feldspar, it is doubtful whether the determination of specific gravity will have any value as a practical test to determine the type of feldspar purchased.

(b) Feldspars after Partial and Complete Fusion Samples were pressed in mullite crucibles, feldspars 1 to 3 fired to cone 4, feldspars 1 to 15 fired to cone 8, all feldspars fired to cone 10, feldspars 13 to 19 fired to cones 12 and 14, feldspars 4 to 12 fired to cone 13. The samples were drawn at the desired "cone" and quenched in running water. They were selected to include those representing incipient and complete fusion as shown by the button test (Fig. 4) and at least one intermediate stage. For instance, Sample 3 (Fig. 4) shows a slight rounding of the edge when fired to cone 4, considerable fusion at cone 8, and flowing at cone 10. All of the feldspars were more or less affected when fired to cone 10 and therefore the complete series was tested and, since the more refractory feldspars were not completely fused at cone 13, an additional firing was made to cone 14 to complete the series.

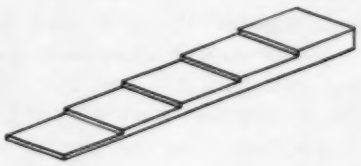

FIG. 4.—Type of vitreous body specimen used in observing relative light transmission.

The results are given in Table VIII. They show that specific gravity of feldspar decreases progressively during firing to cone 14 (approximately 1390°C), but during firing from cones 10 to 14 (approximately 1250 to

[13] *Trans. Amer. Ceram. Soc.*, 9, 204 (1911).
[14] U. S. Geol. Surv., *Bull.*, No. 679 (1921).
[15] "Keramik" (1923), p. 102.

1390°C) the specific gravity changes only slightly, indicating that substantially all of the feldspar has been converted to a glass below cone 10. This change in density has been attributed to the destruction of the definite arrangement of the molecules forming the crystals of which the feldspar is composed, and the production of a more or less homogeneous glass, in which there is little, if any, definite molecular arrangement. Since there is a progressive decrease in density during firing, a corresponding increase in volume might be anticipated. The average reduction in specific gravity of the feldspars fired to cone 4 (Nos. 1, 2, and 3) is 4.4%; fired to cone 8, the average for specimens Nos. 1 to 15 inclusive becomes 7.7%. When fired to cones 10 (all specimens) and 14 (Nos. 13 to 19 inclusive) the average reduction is 8.1 and 9.0%, respectively. Rieke[16] found 7% volume increase on transformation of a crystalline potash feldspar to the amorphous glass.

(6) Thermal Expansion of Feldspar after Partial and Complete Fusion

The thermal expansion observations were made by the interferometer method[17] using specimens broken from the samples prepared for the true specific gravity determinations. The data obtained (Table IX) show that the expansion increases quite uniformly up to a temperature of about 575°C, which is the approximate conversion temperature of quartz from the α to the β form. Above this temperature the rate of expansion may remain practically unchanged if little or no uncombined silica is present (*e.g.*, feldspar 19) or it may increase through the approximate range of 575 to 600°C if appreciable quantities of uncombined silica are present (*e.g.*, feldspars 2, 7, and 13). There is a strong indication that uncombined silica may have a greater effect on the relative thermal expansion of a feldspar than the effect of such variations in percentages of K_2O and Na_2O as are present in the nineteen samples investigated. The relation between percentage of uncombined silica and expansion is direct and fairly close for the series of incompletely fused specimens but becomes less clearly defined as the feldspars are heated to higher temperatures. This change in relation is conceivably due to progressive solution of the uncombined silica with increase in temperature. It is of interest to note that the observed thermal expansions of those fused feldspars containing less than 4% uncombined silica (Nos. 1, 18, and 19) may be approximated by calculation using the factors for glazes as determined by Hall.[18] No relation between thermal expansion and fineness of grind is indicated and any relation which may exist between the expansion, the degree of fusion,

[16] "Keramik," p. 102, Felix Singer (a reference from R. Rieke).
[17] Bur. Stand., *Sci. Paper*, No. 485.
[18] *Jour. Amer. Ceram. Soc.*, **13** [3], 182 (1930).

Table IX

Percentage Linear Expansion of Partially and Completely Fused Feldspars

Feldspar No.	Fired to Cone	Expansion at °C	Expansion in %	Expansion at °C	Expansion in %	Expansion at °C	Expansion in %	Expansion at °C	Expansion in %	Expansion at °C	Expansion in %	Expansion at °C	Expansion in %	Expansion at °C	Expansion in %	Expansion at °C	Expansion in %	Expansion at °C	Expansion in %	Expansion at °C	Expansion in %	Expansion at °C	Expansion in %	Expansi at °C	Expansi in %
1	4	76	0.020	115	0.038	211	0.091	241	0.109	313	0.143	366	0.177	401	0.194	459	0.227	515	0.261	547	0.277	582	0.294	631	0.3
	8	45	0.009	98	0.042	196	0.129	254	0.174	298	0.205	359	0.250	394	0.281	453	0.326	496	0.356	559	0.401	575	0.416	626	0.4
	10	45	0.010	120	0.067	192	0.123	256	0.178	313	0.214	354	0.250	403	0.286	452	0.322	498	0.357	542	0.393	596	0.428	634	0.4
2	4	43	0.009	98	0.035	192	0.086	246	0.118	313	0.150	361	0.182	408	0.213	454	0.245	503	0.276	556	0.323	582	0.353	611	0.3
	8	66	0.033	112	0.066	211	0.159	241	0.180	323	0.252	354	0.283	417	0.343	448	0.374	512	0.434	540	0.465	575	0.510	593	0.5
	10	55	0.021	81	0.040	206	0.152	241	0.189	295	0.225	337	0.262	415	0.334	452	0.370	491	0.406	533	0.441	568	0.477	604	0.5
3	4	55	0.013	104	0.038	208	0.096	248	0.119	298	0.141	337	0.164	408	0.208	452	0.230	517	0.263	561	0.285	575	0.296	601	0.3
	8	48	0.011	102	0.051	206	0.146	246	0.184	298	0.221	366	0.277	408	0.314	450	0.351	517	0.406	554	0.434	573	0.443	608	0.4
	10	50	0.012	108	0.056	203	0.140	248	0.182	304	0.223	359	0.274	424	0.325	457	0.356	508	0.397	559	0.437	579	0.457	604	0.4
4	8	45	0.013	100	0.051	192	0.147	251	0.195	313	0.243	361	0.289	413	0.336	457	0.383	512	0.429	554	0.476	582	0.522	618	0.5
	10	43	0.011	112	0.063	181	0.123	243	0.181	298	0.221	344	0.260	403	0.317	445	0.356	487	0.394	568	0.471			622	0.5
	13	40	0.013	93	0.049	211	0.143	238	0.166	304	0.212	359	0.257	408	0.302	463	0.347	491	0.369	556	0.414	579	0.436	599	0.4
5	8	48	0.018	106	0.056	190	0.141	262	0.204	295	0.226	361	0.288	408	0.329	452	0.371	517	0.432	556	0.474	582	0.514	606	0.5
	10	45	0.012	102	0.055	196	0.140	241	0.181	292	0.223	342	0.264	413	0.325	461	0.366	508	0.406	547	0.447	577	0.487	606	0.5
	13	48	0.013	88	0.040	199	0.116	254	0.165	292	0.189	357	0.238	410	0.286	443	0.310	510	0.358	559	0.394	579	0.418	613	0.4
6	8	45	0.011	88	0.044	201	0.149	259	0.211	292	0.232	361	0.293	415	0.334	466	0.385	505	0.425	556	0.476	579	0.516	613	0.5
	10	55	0.017	104	0.050	215	0.162	251	0.193	292	0.225	359	0.287	396	0.318	461	0.380	519	0.442	545	0.472	582	0.534	606	0.5
	13	43	0.014	102	0.055	215	0.158	243	0.184	315	0.235	346	0.260	399	0.311	452	0.361	501	0.411	556	0.461	579	0.485	606	0.5
7	8	43	0.013	90	0.051	192	0.149	265	0.221	295	0.245	344	0.293	408	0.364	452	0.411	515	0.481	552	0.528	575	0.575	604	0.6
	10	45	0.015	102	0.059	192	0.142	254	0.197	289	0.225	349	0.279	405	0.333	466	0.387	519	0.440	559	0.494	579	0.520	604	0.5
	13	43	0.012	90	0.048	203	0.138	251	0.182	313	0.226	359	0.269	405	0.313	452	0.356	510	0.420	547	0.463	579	0.506	606	0.5
8	8	45	0.017	115	0.068	192	0.133	268	0.197	313	0.229	349	0.261	415	0.324	443	0.355	505	0.418	566	0.480			606	0.5
	10	50	0.017	115	0.063	208	0.151	238	0.180	323	0.239	349	0.267	417	0.324	452	0.353	484	0.372	554	0.439	584	0.467	599	0.4
	13	43	0.012	120	0.067	190	0.131	265	0.193	295	0.214	349	0.256	394	0.297	466	0.358	512	0.399	535	0.419	577	0.460	606	0.4
9	8	43	0.014	93	0.055	183	0.133	259	0.210	298	0.236	349	0.286	405	0.337	454	0.387	508	0.437	559	0.488	577	0.513	613	0.5
	10	43	0.017	100	0.065	194	0.157	262	0.218	298	0.248	361	0.308	392	0.338	448	0.398	501	0.458	556	0.517	577	0.547	606	0.6
	13	40	0.012	93	0.048	194	0.138	248	0.182	310	0.226	357	0.270	410	0.335	452	0.378	498	0.421	542	0.464	561	0.486	593	0.5
10	8	53	0.016	110	0.062	206	0.150	238	0.179	315	0.237	346	0.266	405	0.323	468	0.380	505	0.408	566	0.465	589	0.493	629	0.5
	10	55	0.017	98	0.049	201	0.141	274	0.202	310	0.232	346	0.262	403	0.307	448	0.351	498	0.396	549	0.440	566	0.455	606	0.4
	13	43	0.015	102	0.058	203	0.142	265	0.196	310	0.224	366	0.278	394	0.304	454	0.358	484	0.385	517	0.411	545	0.438	589	0.4
11	8	45	0.014	96	0.052	203	0.151	251	0.200	313	0.248	366	0.296	394	0.320	443	0.368	496	0.416	549	0.464	587	0.511	616	0.5
	10	48	0.016	104	0.059	192	0.142	248	0.196	320	0.251	346	0.278	405	0.332	466	0.385	498	0.412	559	0.466	579	0.492	599	0.5
	13	35	0.011	83	0.045	188	0.132	265	0.195	295	0.216	346	0.358	394	0.299	459	0.361	505	0.402	570	0.464	582	0.485	604	0.5
12	8	45	0.015	103	0.057	188	0.137	241	0.190	310	0.243	364	0.295	396	0.321	454	0.373	517	0.425	545	0.451	570	0.477	604	0.5
	10	62	0.021	110	0.060	194	0.136	251	0.192	301	0.230	361	0.285	408	0.322	450	0.359	503	0.414	556	0.469	577	0.488	591	0.5
	13	40	0.013	93	0.049	203	0.140	256	0.185	295	0.208	346	0.253	401	0.297			501	0.385	554	0.429	577	0.451	599	0.4
13	8	53	0.018	108	0.053	194	0.134	268	0.199	313	0.232	349	0.264	424	0.327	461	0.359	505	0.391	564	0.454	587	0.485	626	0.5
	10	45	0.014	102	0.054	196	0.145	251	0.196	283	0.221	344	0.272	405	0.322	463	0.372	491	0.397	545	0.447	579	0.485	599	0.5
	12	58	0.017	102	0.050	203	0.143	243	0.174	307	0.220	361	0.265	399	0.296	463	0.356	491	0.386	552	0.431	577	0.461	611	0.4
	14	38	0.012	90	0.048	192	0.138	238	0.183	292	0.227	346	0.271	396	0.315	452	0.358	512	0.402	542	0.424	568	0.446	591	0.4
14	8	40	0.010	104	0.057	206	0.146	243	0.181	295	0.216	357	0.268	394	0.302	459	0.354	501	0.388	545	0.423	577	0.457	608	0.4
	10	45	0.014	100	0.055	208	0.158	234	0.184	307	0.235	337	0.261	387	0.311	443	0.361	510	0.412	535	0.437	579	0.487	599	0.5
	12	43	0.015	93	0.057	215	0.167	246	0.194	283	0.221	349	0.274	403	0.327	459	0.380	489	0.407	552	0.459	579	0.486	599	0.5
	14	43	0.013	115	0.070	213	0.158	241	0.180	313	0.224	361	0.267	413	0.310	459	0.353	517	0.396	547	0.417	570	0.438	593	0.4
15	8	45	0.015	112	0.060	206	0.144	248	0.172	292	0.200	359	0.255	403	0.296	452	0.337	501	0.378	559	0.432	582	0.459	608	0.4
	10	43	0.010	98	0.054	192	0.138	246	0.188	292	0.222	351	0.271	405	0.320	459	0.370	501	0.402	559	0.451	575	0.468	608	0.5
	12	43	0.014	99	0.053	208	0.154	241	0.179	298	0.228	366	0.277	394	0.302	454	0.350	512	0.399	545	0.423	570	0.447	593	0.4
	14	45	0.017	93	0.050	188	0.130	265	0.193	313	0.224	346	0.255	385	0.285	466	0.347	508	0.378	545	0.408	579	0.438	599	0.4
16	10	43	0.014	93	0.053	206	0.153	265	0.203	298	0.227	361	0.276	413	0.325	440	0.339	491	0.397	547	0.446	570	0.470	616	0.5
	12	38	0.012	112	0.070	206	0.158	259	0.202	289	0.224	342	0.268	408	0.332	452	0.375	505	0.418	549	0.461	570	0.483	601	0.5
	14	40	0.012	115	0.068	206	0.153	265	0.195	295	0.216	375	0.279	405	0.300	454	0.341	510	0.383	566	0.424	589	0.445	616	0.4
17	10	48	0.014	108	0.054	201	0.129	268	0.179	313	0.204	344	0.228	405	0.277	440	0.301	510	0.350	547	0.374	575	0.398	601	0.4
	12	55	0.023	102	0.049	196	0.128	234	0.159	326	0.221	361	0.252	419	0.298	463	0.328	503	0.358	538	0.389	575	0.419	613	0.4
	14	45	0.015	112	0.058	215	0.141	254	0.168	298	0.195	368	0.249	401	0.275	463	0.328	498	0.355	552	0.394	582	0.421	613	0.4
18	10	45	0.012	93	0.047	192	0.138	246	0.182	307	0.227	359	0.271	417	0.314	450	0.336	501	0.380	552	0.423	577	0.445	613	0.4
	12	50	0.012	104	0.056	199	0.140	238	0.171	304	0.213	351	0.254	401	0.295	454	0.336	503	0.376	568	0.417	593	0.438	624	0.4
	14	62	0.011	98	0.045	203	0.145	241	0.178	289	0.211	344	0.244	403	0.293	461	0.341	512	0.373	542	0.398	570	0.414	611	0.4
19	10	45	0.010	102	0.046	199	0.132	262	0.183	292	0.200	366	0.251	417	0.284	461	0.317	491	0.334	540	0.367	570	0.384	599	0.4
	12	43	0.008	102	0.054	206	0.149	262	0.193	304	0.222	346	0.358	407	0.308	445	0.336	523	0.392	558	0.421	577	0.435	593	0.4
	14	45	0.010	98	0.048	203	0.146	265	0.199	310	0.234	346	0.269	403	0.321	463	0.373	510	0.408	549	0.442	570	0.460	593	0.4

TABLE IX

EXPANSION OF PARTIALLY AND COMPLETELY FUSED FELDSPARS

Expansion at °C	Expansion in %	Expansion at °C	Expansion in %	Expansion at °C	Expansion in %	Expansion at °C	Expansion in %	Expansion at °C	Expansion in %	Expansion at °C	Expansion in %	Expansion at °C	Expansion in %	Expansion at °C	Expansion in %
6	0.177	401	0.194	459	0.227	515	0.261	547	0.277	582	0.294	631	0.311	677	0.328	705	0.344
9	0.250	394	0.281	453	0.326	496	0.356	559	0.401	575	0.416	626	0.446	658	0.461	717	0.477
4	0.250	403	0.286	452	0.322	498	0.357	542	0.393	596	0.428	634	0.446			745	0.465
1	0.182	408	0.213	454	0.245	503	0.276	556	0.323	582	0.353	611	0.369	652	0.385	724	0.416
4	0.283	417	0.343	448	0.374	512	0.434	540	0.465	575	0.510	593	0.540			707	0.571
7	0.262	415	0.334	452	0.370	491	0.406	533	0.441	568	0.477	604	0.531	650	0.549		
7	0.164	408	0.208	452	0.230	517	0.263	561	0.285	575	0.296	601	0.317	652	0.329	705	0.349
6	0.277	408	0.314	450	0.351	517	0.406	554	0.434	573	0.443	608	0.471	652	0.498	705	0.517
9	0.274	424	0.325	457	0.356	508	0.397	559	0.437	579	0.457	604	0.478	670	0.518	731	0.529
1	0.289	413	0.336	457	0.383	512	0.429	554	0.476	582	0.522	618	0.568	646	0.580	731	0.604
4	0.260	403	0.317	445	0.356	487	0.394	568	0.471			622	0.528	684	0.538		
9	0.257	408	0.302	463	0.347	491	0.369	556	0.414	579	0.436	599	0.459	648	0.481		
1	0.288	408	0.329	452	0.371	517	0.432	556	0.474	582	0.514	606	0.535	682	0.556	738	0.567
2	0.264	413	0.325	461	0.366	508	0.406	547	0.447	577	0.487	606	0.508	665	0.528	722	0.539
7	0.238	410	0.286	443	0.310	510	0.358	559	0.394	579	0.418	613	0.442	648	0.454	705	0.467
1	0.293	415	0.334	466	0.385	505	0.425	556	0.476	579	0.516	613	0.546	660	0.557		
9	0.287	396	0.318	461	0.380	519	0.442	545	0.472	582	0.534	606	0.549	640	0.565	684	0.580
6	0.260	399	0.311	452	0.361	501	0.411	556	0.461	579	0.485	606	0.523	674	0.548		
4	0.293	408	0.364	452	0.411	515	0.481	552	0.528	575	0.575	604	0.622	656	0.646	709	0.658
9	0.279	405	0.333	466	0.387	519	0.440	559	0.494	579	0.520	604	0.573	660	0.600		
9	0.269	405	0.313	452	0.356	510	0.420	547	0.463	579	0.506	606	0.549	650	0.571	712	0.592
9	0.261	415	0.324	443	0.355	505	0.418	566	0.480			606	0.543	646	0.574	707	0.590
9	0.267	417	0.324	452	0.353	484	0.372	554	0.439	584	0.467	599	0.481	640	0.510	743	0.524
9	0.256	394	0.297	466	0.358	512	0.399	535	0.419	577	0.460	606	0.481	640	0.501	705	0.532
9	0.286	405	0.337	454	0.387	508	0.437	559	0.488	577	0.513	613	0.563	648	0.575		
1	0.308	392	0.338	448	0.398	501	0.458	556	0.517	577	0.547	606	0.606	658	0.635	720	0.651
7	0.270	410	0.335	452	0.378	498	0.421	542	0.464	561	0.486	593	0.528	660	0.572	722	0.594
6	0.266	405	0.323	468	0.380	505	0.408	566	0.465	589	0.493	629	0.522	679	0.536	757	0.551
6	0.262	403	0.307	448	0.351	498	0.396	549	0.440	566	0.455	606	0.499	672	0.529	741	0.544
6	0.278	394	0.304	454	0.358	484	0.385	517	0.411	545	0.438	589	0.491	648	0.531	719	0.558
6	0.296	394	0.320	443	0.368	496	0.416	549	0.464	587	0.511	616	0.535			717	0.547
6	0.278	405	0.332	466	0.385	498	0.412	559	0.466	579	0.492	599	0.519	638	0.546	737	0.573
6	0.358	394	0.299	459	0.361	505	0.402	570	0.464	582	0.485	604	0.505	638	0.526	737	0.567
4	0.295	396	0.321	454	0.373	517	0.425	545	0.451	570	0.477	604	0.516			717	0.530
1	0.285	408	0.322	450	0.359	503	0.414	556	0.469	577	0.488	591	0.506	640	0.543	682	0.561
6	0.253	401	0.297			501	0.385	554	0.429	577	0.451	599	0.473	650	0.506	712	0.528
9	0.264	424	0.327	461	0.359	505	0.391	564	0.454	587	0.485	626	0.517	665	0.533	751	0.549
4	0.272	405	0.322	463	0.372	491	0.397	545	0.447	579	0.485	599	0.509	640	0.534	724	0.560
1	0.265	399	0.296	463	0.356	491	0.386	552	0.431	577	0.461	611	0.491			696	0.507
6	0.271	396	0.315	452	0.358	512	0.402	542	0.424	568	0.446	591	0.468	658	0.511	707	0.533
7	0.268	394	0.302	459	0.354	501	0.388	545	0.423	577	0.457	608	0.483			722	0.492
7	0.261	387	0.311	443	0.361	510	0.412	535	0.437	579	0.487	599	0.511	636	0.536	712	0.562
9	0.274	403	0.327	459	0.380	489	0.407	552	0.459	579	0.486	599	0.514	634	0.538	712	0.565
1	0.267	413	0.310	459	0.353	517	0.396	547	0.417	570	0.438	593	0.460	656	0.502	719	0.534
9	0.255	403	0.296	452	0.337	501	0.378	559	0.432	582	0.459	608	0.486	663	0.513	715	0.527
1	0.271	405	0.320	459	0.370	501	0.402	559	0.451	575	0.468	608	0.500	640	0.516	698	0.533
6	0.277	394	0.302	454	0.350	512	0.399	545	0.423	570	0.447	593	0.471	652	0.508	691	0.520
6	0.255	385	0.285	466	0.347	508	0.378	545	0.408	579	0.438	599	0.454	640	0.484	694	0.515
1	0.276	413	0.325	440	0.339	491	0.397	547	0.446	570	0.470	616	0.518	662	0.542	701	0.554
2	0.268	408	0.332	452	0.375	505	0.418	549	0.461	570	0.483	601	0.525	660	0.558	694	0.568
5	0.279	405	0.300	454	0.341	510	0.383	566	0.424	589	0.445	616	0.465	650	0.486	722	0.517
4	0.228	405	0.277	440	0.301	510	0.350	547	0.374	575	0.398	601	0.422	646	0.447	682	0.459
1	0.252	419	0.298	463	0.328	503	0.358	538	0.389	575	0.419	613	0.449	668	0.479	701	0.495
8	0.249	401	0.275	463	0.328	498	0.355	552	0.394	582	0.421	613	0.447	656	0.473	694	0.487
9	0.271	417	0.314	450	0.336	501	0.380	552	0.423	577	0.445	613	0.467	652	0.489	698	0.510
1	0.254	401	0.295	454	0.336	503	0.376	568	0.417	593	0.438	624	0.458	665	0.478	704	0.489
4	0.244	403	0.293	461	0.341	512	0.373	542	0.398	570	0.414	611	0.446	670	0.478	712	0.495
6	0.251	417	0.284	461	0.317	491	0.334	540	0.367	570	0.384	599	0.401	672	0.434	705	0.442
6	0.358	407	0.308	445	0.336	523	0.392	558	0.421	577	0.435	593	0.449	658	0.492	701	0.520
6	0.269	403	0.321	463	0.373	510	0.408	549	0.442	570	0.460	593	0.477	646	0.512	709	0.546

and the soda-potash ratio of the feldspar is apparently obscured by the uncombined silica. Values are given in Table IX.

(7) Petrographic Analysis

(a) As Received A comprehensive study, the results of which have been published in a separate report,[19] was made to develop more satisfactory microscopic methods than those usually employed for determining quantitatively the mineral constituents in feldspar. Several methods were tried and the method of counting the grains while using a liquid of index of refraction 1.540 for distinguishing quartz from feldspar and a liquid of index 1.528 for distinguishing potash from plagioclase feldspar was finally adopted. This so-called counting method gives satisfactory results for plant control in terms of potash feldspar, plagioclase feldspar, and quartz when used by a skilled microscopist. The nineteen commercial feldspars were analyzed by this method and the results compared with the results obtained by computing the relative amounts of the mineral constituents from their chemical analyses. A modification of the method proposed by Booze and Klein[20] in which a partially fused sample was examined microscopically was also found suitable for estimating quartz and could be used with satisfactory results

TABLE X

COMPARISON OF RESULTS OBTAINED BY DIFFERENT ANALYTICAL METHODS
(Values taken from Table VII of H. Insley's report; see footnote 19)

	Potash Feldspar		Plagioclase Feldspar		Quartz	
Feldspar No.	*a*(%)	*b*(%)	*a*(%)	*b*(%)	*a*(%)	*b*(%)
1	6.1	3.1	88.0	93.1	2.8	1.9
2	26.8	20.9	51.4	57.0	21.8	19.4
3	31.0	30.3	51.8	62.1	11.4	6.1
4	37.9	33.7	34.5	39.1	20.4	24.1
5	41.7	35.2	33.6	40.3	21.2	21.8
6	45.0	38.2	31.2	37.8	20.0	21.7
7	44.8	30.2	26.5	41.2	25.1	26.7
8	49.7	47.9	34.9	36.8	11.3	12.6
9	52.9	51.9	28.2	27.3	17.6	20.0
10	52.3	50.2	32.2	32.2	10.6	14.2
11	54.1	50.6	31.1	36.6	12.4	11.6
12	56.5	48.1	29.3	39.9	12.5	11.6
13	57.9	56.0	27.0	29.7	12.0	12.0
14	60.4	60.3	23.4	28.2	12.6	10.0
15	59.8	75.8	28.1	19.1	8.5	3.9
16	62.0	60.9	22.3	26.7	12.7	11.6
17	72.5	84.0	11.9	12.1	6.9	3.5
18	72.4	85.2	23.4	11.7	1.9	2.3
19	76.7	93.4	18.7	5.4	2.2	0.8

a = computed from chemical analysis.
b = microscopic count method.

[19] *Jour. Amer. Ceram. Soc.*, **10** [9], 651 (1927).
[20] *Jour. Amer. Ceram. Soc.*, **6** [6], 698 (1923).

by the plant technologist. Neither the counting method nor the fusion method is as accurate as computations from accurate chemical analyses.

TABLE XI

RESULTS OF THE PETROGRAPHIC EXAMINATION OF PARTIALLY AND COMPLETELY FUSED FELDSPAR

Feldspar No.	Cone	Quartz (%)	Unmelted feldspar (%)	Index of glass	Remarks
1	4	No thin section		1.488	Very large amount of unmelted feldspar; no quartz solution
	8	2	1	1.488	Possibly slight rounding of quartz grains
	10	2	None	1.488	Quartz grains somewhat rounded
2	4	No thin section			Very largely unmelted feldspar; only interstitial glass present; a few grains of augite or hornblende present; index determination impossible
	8	19	None	1.489*	Quartz grains somewhat rounded
	10	19	"	1.489*	Quartz grains somewhat rounded
3	8	7	"	1.489	Quartz grains angular; a few partly transformed clay grains which show fine mullite needles and rarely 60° structure
	10	6	"	1.489	A grain or two showing unmistakable, well-developed mullite needles
10	8	15**	†	1.489*	Some unmelted feldspar; a few lumps of partly transformed clay containing small mullite needles (not > 3%); no quartz solution
	10	13	None	1.490	Slight rounding of corners of quartz grains; a few partly transformed clay grains with small mullite needles
	13	8	"	1.490	Quartz grains rounded
18	10	3	0.1	1.486	Smaller quartz grains slightly rounded
	12	2	None	1.486	Quartz grains slightly rounded
	14	1	"	1.486	Quartz grains rounded
19	10	16**	†	1.489	Much unmelted feldspar; quartz apparently undissolved
	12	1	0.1	1.487	Quartz grains slightly rounded; a very few partly transformed clay grains; a few opaque pyrite grains
	14	<1	None	1.487	Quartz grains rounded

* Variable; average result given.
** Includes unmelted feldspar.
† Included with quartz.

The results obtained by the adopted counting method are given for convenience in Table X, together with the compositions as calculated from chemical analyses.

(b) After Partial and Complete Fusion Petrographic analyses were made on the following samples:

Feldspar No.	Fired to Cones
1	4, 8, and 10
2	4, 8, and 10
3	8 and 10
10	8, 10, and 13
18	10, 12, and 14
19	10, 12, and 14

These six feldspars were chosen for petrographic examination because they represent the high soda, and high, low, and intermediate potash content feldspars, and also wide variations in the percentage of uncombined silica. Petrographic examinations were made on powdered samples of each specimen, and on thin sections of all specimens except two (feldspars 1 and 2 fired to cone 4) which could not be obtained on account of their extreme brittleness.

Micrometer measurements were made on all sections, using the Wentworth micrometer to determine the amount of quartz present and, when possible, the amount of unmelted feldspar. Index measurements were made on the glass in all samples where sufficient glass was present. The results of these analyses are given in Table XI. It is interesting to note that the glass formed in each case has practically the same index of refraction.

Part 2. Comparative Behavior of Bodies in Which Feldspar Is the Only Variable Component

The compositions of the "vitreous" and "semivitreous" bodies[21] and the glazes proposed by the Bureau for use in this study are given in Table XII. For comparison, the typical bodies suggested by the Advisory Committee to the Bureau[22] are also given; these bodies were not suggested until after the work on the Bureau bodies was nearly completed. The vitreous bodies and glaze mature at cone 12 (the glaze is good also at cone

TABLE XII

COMPOSITION OF BODIES AND GLAZES IN PER CENT

Vitreous Bodies

Used by the Bureau		Suggested by the Committee*	
Ball clay (Tenn. No. 5)	7.5	Ball clay (Great Beam English)	8.0
Kaolin (Fla.)	8.0	Kaolin (Fla.E.P.K.)	6.0
China clay (English)	29.0	China clay (A-1 English)	22.0
Flint	36.0	China clay (MGR-2 English)	11.0
Whiting	1.5	Flint (National Silica Co.)	34.5
Feldspar	18.0	Whiting (English Cliffstone)	2.5
		Feldspar	16.0

[21] The "vitreous" body and feldspar No. 6 of the present investigation are practically equivalent to body 16 and the feldspar used in the work reported in *Tech. Paper*, No. 30. In the present investigation those bodies having less than 0.5% porosity after firing to their respective and predetermined maturing temperatures are designated as vitreous, while those bodies of higher porosity are designated as semivitreous.

[22] Bureau Advisory Committee on Ceramics appointed by the industry to confer with the Bureau in planning and conducting experimental work in ceramics.

TABLE XII (*continued*)

Semivitreous Bodies

Ball clay (Tenn. No. 5)	15.0	Ball clay (Higmans No. 12)	13.0
Kaolin (Fla.)	8.0	Kaolin (Fla., Edgar)	6.0
China clay (English)	29.0	Kaolin (N. C., Harris)	9.0
Flint	34.0	China clay (Pooles No. 1)	12.5
Feldspar	14.0	China clay (Pooles No. 10)	12.0
		Flint	35.0
		Feldspar (Maine)	12.5

Glazes

For Vitreous Bodies		For Semivitreous Bodies		Frit	
Feldspar	37.0	Frit	30.9	Flint	59.4
Whiting	13.8	Feldspar	30.8	Florida kaolin	5.4
Barium carbonate	8.0	Whiting	13.8	Borax	10.6
Florida kaolin	10.6	Florida kaolin	3.4	Boric acid	22.4
Flint	21.8	White lead	17.9	Whiting	2.2
Tin oxide	3.8	Zinc oxide	3.2		
Magnesium carbonate	5.0				

* These bodies were suggested as typical commercial bodies by the Advisory Committee of the Bureau of Standards.

10) and satisfactory glazed specimens were obtained either by the "one-fire" or "two-fire" process. The semivitreous bodies mature at cones 8 to 9 and the glaze at cone 6.

The bodies were prepared by wet grinding for six hours, sieving, removal of iron from the slip by magnetic separation, filter pressing, and storage

TABLE XIII

PERCENTAGE VOLUME SHRINKAGE AND POROSITY OF FIRED BODIES

Semivitreous
(Porosity Values Are Average of 3 Specimens)
(Volume Shrinkage Values Are Average of 5 Specimens)

	Porosity				Volume Shrinkage				
Body No.	Cone 4 in 54 hrs.	Cone 6 in 30½ hrs.	Cone 8 in 40 hrs.	Cone 12 in 48½ hrs.	Cone 4 in 54 hrs.	Cone 6 in 30½ hrs.	Cone 8 in 40 hrs.	Cone 12 in 48½ hrs.	Cone 12 in 5 days
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	19.6	12.8	4.8	0.0	20.0	25.0	28.2	30.7	35.4
2	21.8	15.9	10.9	1.3	16.4	21.4	23.9	30.7	35.4
3	21.1	12.3	6.3	0.0	18.7	24.2	28.0	32.3	34.1
4	21.4	15.2	8.5	0.5	17.0	22.4	28.4	32.0	34.5
5	22.6	15.9	5.1	0.0	17.4	23.2	29.5	32.6	34.7
6	22.6	16.5	5.7	0.0	15.3	19.8	25.6	31.5	37.0
7	24.7	16.4	11.3	0.0	14.5	21.9	25.0	32.0	36.3
8	21.7	12.5		0.0	17.3	24.9	30.1	33.2	35.4
9	23.3	17.3	12.7	0.0	16.5	21.0	24.5	33.6	35.5
10	23.1	13.3	10.5	0.0	18.5	24.8	28.0	33.3	35.3
11	22.5	14.1	6.4	0.0	16.4	23.5	27.9	33.0	35.0
12	23.0	15.0	10.0	0.0	16.4	22.0	25.7	32.8	35.4
13	23.2	12.5	11.7	0.0	16.5	24.6	27.4	33.2	35.5
14	21.8	12.2	8.0	0.0	17.9	24.8	28.9	33.9	35.5
15	23.6	12.3	8.9	0.0	16.0	23.6	25.2	31.9	35.0
16	22.8	15.5	13.0	0.0	17.0	23.6	25.2	33.1	36.3
17	19.6	13.8	9.7	0.0		23.1	26.6	33.7	36.9
18	19.8	14.4	10.2	0.0	18.0	22.0	25.8	33.0	35.1
19	22.6	14.7	6.3	0.0	17.8	22.0	30.1	33.4	35.7

TABLE XIII (*concluded*)

Vitreous
(Porosity Values Are Average of 3 Specimens)
(Volume Shrinkage Values Are Average of 5 Specimens)

Body No.	Porosity			Volume Shrinkage			
	Cone 6 in 30½ hrs.	Cone 8 in 40 hrs.	Cone 12 in 48½ hrs.	Cone 6 in 30½ hrs.	Cone 8 in 40 hrs.	Cone 12 in 48½ hrs.	Cone 12 in 5 days
	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	7.0	1.3	0.0	27.0	29.6	30.8	31.3
2	8.8	0.5	0.0	26.2	30.3	30.8	31.9
3	7.2	0.0	0.0	27.9	32.7	31.5	28.4
4	6.2	0.1	0.0	25.7	28.7	28.4	30.6
5	9.3	0.3	0.0	27.3	32.4	32.0	31.3
6	10.3	0.1	0.0	24.7	32.9	31.0	32.4
7	6.7	0.8	0.0	27.5	31.4	31.6	32.6
8	6.5	0.4	0.0	29.3	32.1	30.1	21.7
9	12.0	2.0	0.0	24.7	31.8	32.5	29.3
10	7.8	0.7	0.0	28.9	31.9	31.4	25.7
11	9.7	0.1	0.0	24.9	31.0	30.1	29.1
12	6.2	0.1	0.0	27.1	30.7	31.1	28.0
13	7.3	1.1	0.0	25.9	30.1	30.2	28.4
14	9.4		0.0	26.4		32.9	29.4
15	7.3	0.4	0.0	30.0	32.4	31.3	27.3
16	12.6		0.0	24.6	29.6	31.1	30.4
17	11.0	1.2	0.0	26.6	32.1	32.7	29.0
18	7.2	0.9	0.0	26.6	29.9	30.0	27.1
19	5.3	0.1	0.0	28.7	31.8	31.6	28.5

of the filter-press cakes in a damp closet until used. The bodies proposed by the Bureau are designated by V for vitreous, SV for semivitreous, and the number of the body and of the glaze indicates the feldspar used in compounding it. The bodies suggested by the Committee are differentiated by placing the letter C after the feldspar number.

(1) Firing Behavior and Maturing Range

These properties, which are purely relative, are determined by porosity and volume changes. The measurements were made on 1- by 1- by 2-inch bars of the vitreous and semivitreous bodies after firing to a number of temperatures. Porosities of the fired specimens were calculated from their volumes, weights in air after drying at 110°C, and weights after boiling in water five hours and standing in the water for 20 hours. Volumes were determined by the mercury displacement method. The results are given in Table XIII; the values for porosity are the average of three, and those for volume shrinkage the average of five, determinations.

The percentage apparent porosity was calculated by means of the following formula:

$$P = \frac{Sf - Df}{Vf} \times 100$$

Where

P = percentage apparent porosity
Sf = weight of saturated fired test piece in grams
Df = weight of dried fired test piece in grams
Vf = volume of fired test piece in ml.

The volume changes during firing were computed from the formula:

$$VS = \frac{Vd - Vf}{Vd} \times 100$$

Where

VS = percentage volume shrinkage
Vd = volume of dry unfired test piece in ml.
Vf = volume of fired test piece in ml.

Table XIV contains group averages of the porosity and volume shrinkage determinations when classified according to the fineness (see Table III) and total fluxes (see Table V). When the accuracy with which these de-

TABLE XIV

GROUP AVERAGES OF BODIES ACCORDING TO GROUPING OF CORRESPONDING FELDSPARS

Group (Table III)		Semi-vitreous Bodies (cone 8)* (%)	Vitreous Bodies (cone 12)† (%)	Group (Table III)	Semi-vitreous Bodies (cone 8)* (%)	Vitreous Bodies (cone 12)† (%)	Group (Table V)	Semi-vitreous Bodies (cone 8)* (%)	Vitreous Bodies (cone 12)† (%)
A	Porosity	8.8	0.0	*a*	8.5	0.0	D	8.6	0.0
	Volume shrinkage	26.4	31.6		27.1	31.8		25.6	31.0
B	Porosity	9.6	0.0	*b*	9.4	0.0	E	9.8	0.0
	Volume shrinkage	27.4	30.9		26.7	30.7		26.9	31.3
C	Porosity	8.2	0.0	*c*	8.7	0.0	F	8.2	0.0
	Volume shrinkage	27.6	30.5		27.9	29.9		27.9	30.8

* Firing made in 40 hours.
† Firing made in 48½ hours.

terminations can be made is considered, it can only be concluded that the figures given indicate that fineness and composition have little, if any, effect on porosity and volume shrinkage.

The per cent volume shrinkage of the vitreous bodies fired to cone 12 in five days, being less in most cases than the shrinkage when fired to cone 12 in two days (Table XIII), indicates that the bodies were somewhat "overfired" after the former treatment, *i.e.*, that a vesicular structure had begun to form, which is a condition held to be highly undesirable because of decreased mechanical strength.[23] Several of the bodies (Nos. 3, 5, 8, 10, 11, and 15) apparently were also overfired after the two-day fire to cone 12. It is not evident why bodies Nos. 1 to 7 (containing the higher percentages of soda feldspar) showed less tendency to overfire, since soda feldspar is the least "refractory" (lowest softening point). Insofar as reducing the possibility of overfiring is concerned there is apparently an advantage in using feldspars of relatively high uncombined SiO_2 content.

[23] *Jour. Amer. Ceram. Soc.*, **6** [6], 915 (1923).

The group of vitreous bodies made with feldspar containing from 0.8 to 13% uncombined SiO_2 showed 3.1% less shrinkage when fired to cone 12 in five days than when fired to cone 12 in two days, and the group made with feldspar containing from 17 to 25% uncombined SiO_2 showed 0.7% less shrinkage. The higher average percentage of uncombined SiO_2 of the feldspars of Group D (Table V) probably accounts for the less pronounced tendency of the corresponding bodies to overfire as compared with the bodies containing feldspars of Groups E and F. It is also worthy of note that the body containing feldspar 8, with the biggest percentage of iron (0.37%) showed the greatest tendency to overfire.

Additional tests were made on five bodies prepared with feldspars 1, 2, 3, 10, and 19. The vitreous bodies, made according to the Bureau formula, were cast and fired to cone 12. The semivitreous bodies, made according to both the Bureau formula and the formula suggested by the Bureau Advisory Committee, were formed into specimens by two methods, casting and extruding; these specimens were fired to cone 8. Specimens of each body were fired according to definite schedules involving four combinations of fast and slow heating and fast and slow cooling.[24]

TABLE XV

PERCENTAGE VOLUME SHRINKAGE DURING FIRING FOR VITREOUS BODIES

(All Bodies Showed Zero Porosity)

Bureau Formula—Cast

Heat* treatment	Percentage Fired Volume Shrinkage Feldspars 1	2	3	10	19	Av.
1A	36.7	37.4	37.2	38.1	37.6	37.4
B	36.2	36.7	36.1	37.5	37.8	36.9
2A	34.8	35.6		36.7	35.9	35.8
B	36.6	36.1	36.9	37.5	38.0	37.0
3A	36.8	36.7	37.1	37.4	36.9	37.0
B	35.3	35.9	35.3	36.9	37.4	36.1
4A	35.5	35.5	35.9	38.9	37.5	36.7
B	36.3	36.4	36.5	37.4	37.4	36.8
Av.	36.0	36.3	36.4	37.5	37.3	36.7

* In heat treatments 1 (A and B), specimens were fired to maturing temperature in 30 hours and cooled from 950° to 450°C at 50° per hour. Slow heating. Fast cooling.
In heat treatments 2 (A and B), specimens were fired to maturing temperature in 30 hours and cooled from 950° to 450°C at 16° per hour. Slow heating. Slow cooling.
In heat treatments 3 (A and B), specimens were fired to maturing temperature in 17 hours and cooled from 950° to 450°C at 50° per hour. Fast heating. Fast cooling.
In heat treatments 4 (A and B), specimens were fired to maturing temperature in 17 hours and cooled from 950° to 450°C at 19° per hour. Fast heating. Slow cooling.

The results of the determinations of volume shrinkage during firing of the vitreous bodies are given in Table XV and of fired volume shrinkage and porosity for the semivitreous bodies are given in Table XVI.

[24] Explained in footnote under Table XV.

TABLE XVI

PERCENTAGE VOLUME SHRINKAGE DURING FIRING AND POROSITY OF FIRED SEMIVITREOUS BODIES

Heat* treatment	Feldspar	Bureau Formula Cast: Fired volume shrinkage (%)	Bureau Formula Cast: Porosity (%)	Bureau Formula Extruded: Fired volume shrinkage (%)	Bureau Formula Extruded: Porosity (%)	Committee Formula Cast: Fired volume shrinkage (%)	Committee Formula Cast: Porosity (%)	All Semivitreous Bodies: Fired volume shrinkage (%)	All Semivitreous Bodies: Porosity (%)
	1	29.7	4.5	31.0	6.0	26.2	10.5		
	2	30.6	6.7	29.8	9.0	24.8	14.3		
1	3	31.5	4.3	32.4	4.9	27.8	10.7		
	10	25.3	10.5	30.0	7.6	25.3	13.5		
	19	23.4	10.4	30.5	7.3	25.6	12.3		
	Av.	28.1	7.3	30.7	7.0	25.9	12.3	28.0	8.9
	1	31.3	5.0	29.8	9.4	28.6	7.8		
	2	30.6	8.9	28.8	10.6	26.8	10.6		
2	3	31.6	7.3	29.1	9.0	29.2	7.7		
	10	33.3	7.4	27.5	11.7	29.9	8.0		
	19	30.0	8.1	28.5	11.0	29.6	7.6		
	Av.	31.3	7.3	28.7	10.3	28.8	8.3	29.6	8.6
	1	31.0	4.7	30.9	5.9	25.9	10.9		
	2	30.7	9.8	28.9	10.5	24.2	15.7		
3	3	31.5	7.0	30.8	7.2	26.6	11.8		
	10	30.8	7.5	28.3	9.8	27.9	9.2		
	19	30.4	6.8	29.5	8.7	27.4	9.3		
	Av.	30.9	7.2	29.7	8.4	26.4	11.4	29.0	9.0
	1	32.5	3.5	29.5	8.6	27.4	9.4		
	2	32.0	5.7	27.6	11.8	30.8	7.9		
	3	34.9	2.3	29.4	9.8	30.6	8.4		
4	10	31.7	6.4	26.9	12.3	31.4	6.9		
	19	32.7	5.1	27.6	11.6	27.5	8.9		
	Av.	32.8	4.6	28.2	10.8	29.6	8.3	30.2	7.9
All bodies All firings av.		30.8	8.8	29.3	9.1	27.7	10.1	29.2	8.6

* Refer to footnote of Table XV.

To obtain further information concerning the behavior of the different feldspars, tests were made on modifications of the following vitreous body (Table XVII) which matures at cone 14:

Body A	Per cent
North Carolina kaolin	30
Georgia kaolin	15
Florida kaolin	10
Flint	25
Potash feldspar (No. 19)	20

The results obtained in the determination of the volume shrinkage during firing are shown in Table XVII. All of the bodies showed zero porosity and the variations in volume shrinkage are so small as to indicate no measurable effect due to the modifications in composition and pretreatment. The data in general indicate that the volume shrinkage during firing and porosity of bodies of the same general composition bear no direct

relation to the kind of feldspar used (Tables XIII and XIV), the kind of heat treatment (Table XV), the manner of making specimens (Table XVI), the calcination of flint and feldspar, or the substitution of French flint for potters' flint (Table XVII). Whether or not these indications are appli-

TABLE XVII

VOLUME SHRINKAGE DURING FIRING OF A SERIES OF BODIES MATURING AT CONE 14

(All of the bodies showed no measurable porosity after firing to cone 14)

Body	Per cent shrinkage	Modulus of rupture (lbs./sq. in.)
(A) 30% N. C., 15% Georgia, 10% Fla. kaolin; 25% flint; 20% feldspar No. 19	33.2	6440
(B) Same composition as Body A except feldspar No. 1 was used instead of No. 19	33.4	7040
(C) Same composition as Body A except flint and feldspar No. 19 were first calcined together at cone 18 and then added to the body	34.1	8440
(D) Same composition as Body A except flint and feldspar No. 1 were calcined together at cone 18 and then added to the body	33.4	7850
(E) Same composition as Body A, but French flint was used instead of potter's flint	32.6	8520
(F) Same composition as Body A, but French flint and feldspar No. 19 were calcined together at cone 18 and then added to the body	36.8	6460

cable to industrial as well as laboratory conditions may properly be questioned. The variations in porosity and shrinkage, as determined, are either so irregular or so small as to make their significance problematical.

Variation between results on specimens of the same body was approximately 2.0% for shrinkage determinations and 1.5% for porosity determinations.

(2) Color and Translucency

(a) Color Visual inspection of thin glazed "butters" showed no difference in color of the various bodies by reflected light. This was checked by determinations with the Pfund colorimeter,[25] the only noteworthy result being the general observation that the bodies were deficient in blue.

(b) Translucency The "translucency" of the nineteen vitreous bodies, and of 50–50 feldspar-quartz mixtures, was determined by means of the Martens photometer.[26] The values obtained may be expressed in terms either of density or transmission (Table XVIII). The zero reading of the instrument (transmission 100% and density zero) is the dial reading of 45°. *Transmission* (or trans-

[25] *Proc. A.S.T.M.*, Part II, pp. 440–48 (1920).

[26] *Physik. Z.*, **1**, 299–303 (1900).

TABLE XVIII

RELATIVE VALUES FOR TRANSLUCENCY AND PHOTOGRAPHIC DENSITY OF VITREOUS BODIES AND FELDSPAR-FLINT MIXTURES

Body No.		Vitreous Bodies Fired to cone 12 in 5 days					Feldspar No.	50 Feldspar / 50 SiO_2 Fired to cone 12 in 5 days					50 Feldspar / 50 SiO_2 Fired to cone 10 in 45½ hours				
	T	0.039	0.059	0.079	0.095	0.113	1	0.083	0.102	0.116	0.127	0.146		0.096	0.113	0.131	0.147
S1	L					9.3						5.5					2.8
	D	1.31	1.62	1.91	2.13	2.40		1.01	1.06	1.12	1.15	1.26		1.24	1.40	1.43	1.55
	T	0.039	0.060	0.080	0.095	0.113	2	0.083	0.101	0.114	0.130	0.150	0.076	0.097	0.116	0.134	0.148
S2	L					5.3						4.5					3.4
	D	1.49	1.78	2.13	2.34	2.72		1.10	1.11	1.21	1.21	1.36	1.17	1.21	1.29	1.42	1.46
	T	0.041	0.061	0.079	0.098	0.117	3	0.090	0.104	0.123	0.140	0.151	0.083	0.100	0.119	0.132	0.147
S3	L					6.7						6.7					4.3
	D	1.43	1.71	1.89	2.19	2.48		0.93	1.01	1.03	1.09	1.17	1.09	1.21	1.27	1.29	1.37
	T	0.041	0.060	0.076	0.093	0.111	4	0.083	0.099	0.114	0.130	0.150	0.076	0.090	0.109	0.126	0.146
S4	L					6.0						6.2					1.6
	D	1.46	1.80	2.04	2.28	2.58		1.03	1.11	1.20	1.25	1.35	1.32	1.37	1.57	1.65	1.80
	T	0.040	0.058	0.078	0.096	0.113	5	0.086	0.105	0.124	0.140	0.156	0.073	0.090	0.109	0.128	0.145
S5	L					6.9						6.5					4.2
	D	1.34	1.62	1.82	2.11	2.37		0.95	1.01	1.09	1.16	1.21	1.04	1.10	1.16	1.17	1.34
	T	0.039	0.059	0.079	0.097	0.114	6	0.084	0.104	0.122	0.138	0.150	0.093	0.110	0.124	0.135	0.150
S6	L					7.2						5.8					3.1
	D	1.33	1.63	1.93	2.15	2.43		1.02	1.08	1.15	1.18	1.25	1.20	1.27	1.35	1.43	1.50
	T	0.040	0.060	0.070	0.095	0.113	7	0.080	0.100	0.112	0.1	0.145	0.075	0.095	0.112	0.130	0.144
S7	L					6.9						5.4					1.5
	D	1.45	1.67	1.98	2.22	2.48		0.96	1.09	1.12	1.15	1.27	1.18	1.38	1.52	1.65	1.82
	T	0.040	0.060	0.078	0.096	0.113	8	0.080	0.099	0.114	0.128	0.148	0.075	0.094	0.108	0.130	0.148
S8	L					7.6						5.0					1.9
	D	1.46	1.74	1.98	2.19	2.44		1.02	1.13	1.17	1.23	1.30	1.14	1.31	1.41	1.57	1.73
	T	0.040	0.060	0.079	0.096	0.113	9	0.082	0.105	0.110	0.135	0.151	0.077	0.093	0.108	0.125	0.144
S9	L					10.6						5.3					3.1
	D	1.37	1.62	1.88	2.05	2.27		0.96	1.09	1.09	1.21	1.27	1.13	1.19	1.35	1.44	1.51
	T	0.041	0.060	0.078	0.096	0.112	10	0.088	0.110	0.125	0.143	0.157	0.078	0.093	0.111	0.126	0.147

S10	L					10.8						6.1					3.9
	D	1.40	1.63	1.82	2.00	2.22		0.91	1.05	1.09	1.16	1.22	1.13	1.18	1.25	1.35	1.41
	T	0.041	0.063	0.081	0.101	0.117	11	0.081	0.100	0.127	0.130	0.151	0.074	0.099	0.115	0.131	0.151
S11	L					9.0						5.8					4.5
	D	1.40	1.70	1.89	2.11	2.38		0.93	1.03	1.13	1.19	1.22	1.06	1.09	1.21	1.27	1.35
	T	0.040	0.060	0.079	0.095	0.113	12	0.090	0.107	0.125	0.142	0.160					
S12	L					11.1						6.5					
	D	1.40	1.62	1.85	2.05	2.28		0.97	1.04	1.10	1.14	1.22					
	T	0.042	0.062	0.083	0.103	0.119	13	0.086	0.105	0.123	0.139	0.157	0.080	0.100	0.115	0.130	0.146
S13	L					8.0						6.0					3.1
	D	1.42	1.70	1.96	2.15	2.55		0.96	1.03	1.10	1.16	1.26	1.10	1.11	1.24	1.38	1.46
	T	0.039	0.058	0.079	0.096	0.114	14	0.087	0.104	0.115	0.137	0.157	0.082	0.104	0.120		0.152
S14	L					8.7						6.7					4.1
	D	1.37	1.62	1.88	2.08	2.37		0.90	0.99	1.02	1.11	1.17	1.09	1.17	1.31		1.46
	T	0.045	0.063	0.080	0.099	0.116	15	0.080	0.100	0.120	0.134	0.150	0.070	0.090	0.106	0.120	0.130
S15	L					11.6						8.2					3.8
	D	1.38	1.60	1.77	2.00	2.23		0.89	0.95	0.98	1.00	1.09	1.07	1.116	1.25	1.36	1.42
	T	0.040	0.059	0.077	0.095	0.112	16	0.077	0.095	0.112	0.130	0.144	0.080	0.097	0.113	0.129	0.147
S16	L					14.4						7.9					3.7
	D	1.29	1.56	1.76	1.94	2.20		0.89	0.95	1.00	1.05	1.10	1.07	1.17	1.25	1.35	1.48
	T	0.042	0.062	0.081	0.099	0.116	17	0.092	0.108	0.123	0.143	0.158	0.088	0.104	0.122	0.140	0.155
S17	L					13.2						6.4					2.0
	D	1.33	1.57	1.76	1.96	2.17		0.93	1.00	1.06	1.14	1.20	1.25	1.38	1.47	1.60	1.67
	T	0.039	0.059	0.079	0.096	0.115	18	0.088	0.108	0.124	0.146	0.160	0.080	0.098	0.116	0.133	0.150
S18	L					12.5						7.6					4.0
	D	1.35	1.54	1.75	1.97	2.22		0.90	0.97	1.01	1.07	1.11	1.07	1.13	1.24	1.32	1.40
	T	0.042	0.062	0.082	0.100	0.115	19	0.090	0.105	0.125	0.138	0.157	0.080	0.099	0.116	0.136	0.154
S19	L					12.5						10.2					3.4
	D	1.37	1.62	1.80	2.04	2.25		0.85	0.90	0.98	1.01	1.07	1.09	1.16	1.26	1.38	1.45

T = thickness in inches.
L = relative values for translucency.
D = photographic density = $-\log L$.

lucency) is the square of the tangent $(45 - \alpha)$ where α is the angle read on the dial through which the nicol prism must be turned from the zero position to "match" the light transmitted through the specimen. *Density* (D, Table XVIII) is equal to $-\log$ L (transmission).

The specimens were made by hand-pressing the body in a steel mold, a dilute solution of gum arabic being used to give the 50–50 feldspar-flint mixes the necessary workability. The form of specimens used is shown in Fig. 4 and the heat treatment, together with density and transmission values, are given in Table XVIII.

The apparatus is shown diagrammatically in Fig. 5. Light from the sources *L-L* passed through the ground glass, *G*, ends of a box approximately six inches cube and was reflected from the white bottom, sides and top, *R*, of the box through an opening approximately one inch square. Light from *L* not passing through the ground glass was shielded from the photometer, *P*, by means of the wooden case, *O*, containing the reflecting chamber *R-R*. The specimen, *S*, was placed so as to cover one-half of the opening. Necessary precautions were taken to assure a dial reading of 45° with no specimen in place. Since the incident light was diffused and the surfaces of the specimens were not ground, the values obtained are only relative. Furthermore, only one (or occasionally two) determination was made on duplicate specimens, so that an appreciable experimental error (probably ±10%) is to be expected. Since the thicknesses of any particular "step" (see Fig. 4) did not vary more than ±5% for all the specimens, mathematical reduction of the relative translucency values to a unit thickness did not seem justified. The translucency (or light-transmission) values (L, Table XVIII) are, therefore, compared without reference to the specimen thickness.

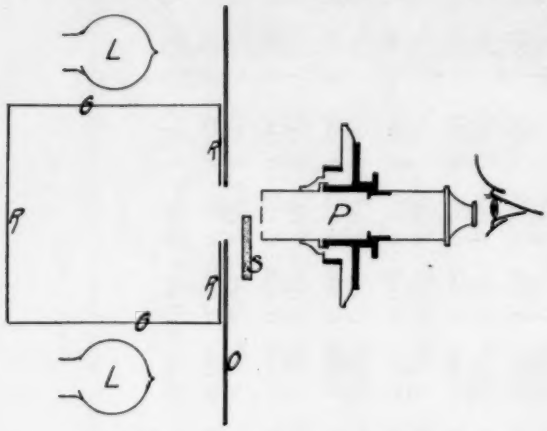

FIG. 5.—Sketch of apparatus used for measuring translucency. *L* = light, *G* = ground glass, *R* = white reflecting surface, *O* = opaque shield, *S* = specimen, *P* = photometer.

The relation between feldspar composition and the light transmission of the corresponding 50–50 mixes fired to cone 10 is very erratic, but a

fairly definite tendency is shown by the mixes and bodies fired to cone 12. For convenience the values are plotted in Fig. 6.

The soda feldspar (No. 1) apparently produces a body equal in translucency to those bodies containing feldspars of intermediate K_2O content. There seems to be a relation, somewhat irregular but sufficiently definite to warrant the conclusion that the percentage K_2O, or the percentage total alkali, which practically parallels the per cent K_2O, is the predominating factor controlling translucency of bodies which have received the same heat treatment. The translucency of the highest potash feldspar bodies is appreciably higher than that of the soda feldspar body.

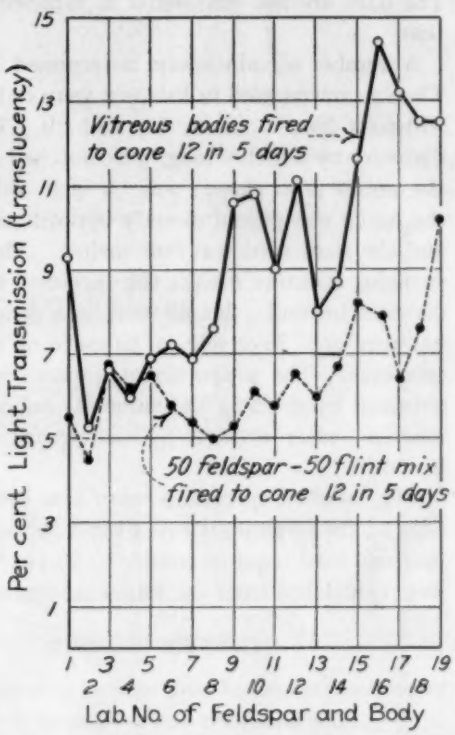
Per cent Light Transmission (translucency)
15
13
11
9
7
5
3
1
Vitreous bodies fired to cone 12 in 5 days
50 feldspar-50 flint mix fired to cone 12 in 5 days
1 3 5 7 9 11 13 15 17 19
2 4 6 8 10 12 14 16 18
Lab. No. of Feldspar and Body

FIG. 6.—Light-transmission values plotted to show relative effect of various feldspars on this property of vitreous bodies.

The translucencies of the 50–50 feldspar-flint mixes (Fig. 6) show a slight and irregular tendency toward increase with the use of feldspars of increasing K_2O content. The method of test might prove useful in determining rates of solution of flint by feldspar if the necessary precautions were taken to prevent devitrification and to eliminate the unequal reflection of light from the surfaces of the specimens by grinding these surfaces to practically the same "smoothness."[27]

(3) Mechanical Strength

During the early part of the investigation a large number of disks (3 inches and 5 inches diameter and $^1/_4$ inch thick) were "jiggered" from each body and fired at the same time as the square bars which were used for porosity and volume-shrinkage determinations. These disks were tested for resistance to chipping and impact according to the method described in the U. S. Govt. Master Specification for Vitrified Chinaware, No. 243*a*.

[27] For further data see Univ. Ill., *Bull.*, No. 154 [Vol. XXIII, No. 31], April 6, 1926.

The average results were nearly the same for all bodies and such variations as were determined showed no apparent relation to any other tests. The variations in values for specimens of the same body usually equaled and often exceeded the variations in the average values for all the bodies. The data are not considered of sufficient significance to warrant publication.

A number of values were determined using the "impact bending test."[28] The specimens used in this test were rods made of the vitreous body using feldspars Nos. 1, 2, 3, 10, and 19. The rods, approximately $^7/_8$ inch diameter by 5 inches long, were notched at the center to give a clean break; the notch (v in shape) was $^1/_4$ inch wide and $^1/_8$ inch deep. In testing, the notch was placed directly opposite the point of impact of the hammer and the span used was four inches. The machine is so designed that the swinging hammer breaks the specimen at the first blow and swings some distance beyond; this distance is a measure of the residual energy in the hammer and, inversely, a measure of the energy required to break the specimen. The proportional impact values (Tables XIX and XX) are obtained by dividing the value (I) indicated on the calibrated scale of the machine, after impact, by the square of the diameter of the specimen tested.[29]

The notched specimens were also broken transversely (with the knife edge of the straining clevis placed in the notch) and the maximum deflection and load required noted.[30] Having these observations, several values were calculated from the following formulas:

$$\text{Modulus of rupture} = \frac{LS}{0.393d^3} \text{ lbs./sq. in.}$$

Proportional measure of work required to break transversely a specimen (of the same material) 1 inch in diameter $= \dfrac{L\Delta}{d^2}$

$$\text{Pliability} = \Delta = \text{maximum deflection in inches}$$

Where

L = load at center of specimen in pounds
S = span (4 inches in these tests)
d = diameter of specimen in inches (notch not allowed for)

All of the values obtained in the determinations of mechanical strength are given in Tables XVII, XIX, and XX. From the data it appears that (1) there is no practical difference produced in the mechanical properties by the kind of heat treatment or the kind of feldspar used; (2) vitreous bodies are stronger than semivitreous bodies; and (3) the cast semivitreous specimens were stronger than the extruded specimens.

[28] Botson and Hyde, Mechanical Testing. Published by E. P. Dutton Co.

[29] The values are relative since no allowance was made for the notch.

[30] For a description of the apparatus used see *Jour. Amer. Ceram. Soc.*, **8** [11], 774 (1925).

TABLE XIX

SUMMARY OF MECHANICAL STRENGTH TESTS OF VITREOUS BODIES

Bureau Formula

	Feldspar No.	Cast Heat Treatment†† 1 A	1 B	2 A	2 B	3 A	3 B	4 A	4 B	Av.
Proportional impact*	1	1.09	1.16	1.11	1.15	1.20	1.26	1.18	1.14	1.16
	2	1.05	1.17	1.17	1.19	1.14	1.24	1.17	1.19	1.16
	3	1.05	1.18		1.15	1.17	1.24	1.19	1.18	1.16
	10	1.05	1.17	1.20	1.15	1.16	1.23	1.21	1.18	1.17
	19	1.07	1.21	1.19	1.16	1.18	1.23	1.22	1.14	1.17
	Av.	1.06	1.18	1.17	1.16	1.17	1.24	1.19	1.16	1.16
Work required to break in transverse test**	1	5,700	7,200	6,800	10,600	7,600	6,900	8,000	10,200	7,900
	2	4,600	10,000	6,000	10,700	8,200	7,200	7,500	7,300	7,700
	3	7,600	9,700		11,200	8,200	7,500	11,000	11,200	9,500
	10	8,000	8,300	10,300	11,400	7,600	9,800	6,100	11,100	9,100
	19	6,400	7,700	8,100	9,900	7,500	7,100	7,200	9,100	7,900
	Av.	6,500	8,600	7,800	10,800	7,800	7,700	8,000	9,800	8,400
Modulus of rupture† (lbs./sq. in.)	1	9,400	9,600	9,900	9,700	10,100	8,900	11,600	8,900	9,800
	2	7,300	10,500	8,800	9,800	10,700	9,300	10,400	9,300	9,500
	3	9,100	10,500		10,100	10,900	9,500	12,600	10,100	10,400
	10	8,200	11,100	9,300	10,400	10,200	10,000	11,300	10,200	10,100
	19	9,400	10,400	9,800	10,100	9,800	9,300	10,600	9,100	9,800
	Av.	8,700	10,400	9,500	10,000	10,300	9,400	11,300	9,500	9,900
Pliability‡ (inches)	1	0.010	0.011	0.010	0.016	0.011	0.011	0.010	0.017	0.012
	2	0.010	0.013	0.010	0.016	0.011	0.011	0.012	0.013	0.012
	3	0.014	0.013		0.016	0.011	0.011	0.011	0.016	0.013
	10	0.015	0.011	0.016	0.016	0.011	0.014	0.008	0.016	0.013
	19	0.011	0.011	0.012	0.015	0.011	0.011	0.010	0.015	0.012
	Av.	0.012	0.012	0.012	0.016	0.011	0.012	0.010	0.015	0.012

* $\frac{I}{d^2}$ (relative values only).

** $\frac{\Delta L}{d^2}$ (relative values only).

† $\frac{LS}{0.393d^3}$.

‡ Maximum deflection in inches.

†† See footnote, Table XV.

TABLE XX

SUMMARY OF MECHANICAL STRENGTH TESTS OF SEMIVITREOUS BODIES

		Bureau Formula										Committee Formula				
		Cast					Extruded					Cast				
	Feldspar	Heat Treatment†					Heat Treatment†					Heat Treatment†				
		1	2	3	4	Av.	1	2	3	4	Av.	1	2	3	4	Av.
Proportional impact*	1	1.06	1.09	1.19	1.05	1.10	1.16	1.02	1.14	1.08	1.10	1.13	1.06	1.11	1.08	1.09
	2	1.07	1.08	1.05	1.02	1.06	1.11	1.02	1.11	1.05	1.05	1.07	1.09	1.02	1.08	1.06
	3	1.08	1.07	1.17	1.10	1.10	1.15	1.03	1.13	1.08	1.10	1.11	1.06	1.08	1.07	1.08
	10	1.03	1.10	1.12	1.08	1.08	1.12	1.07	1.08	1.07	1.08	1.07	1.11	1.13	1.00	1.08
	19	1.06	1.08	1.12	1.09	1.09	1.12	1.00	1.11	1.09	1.08	1.06	1.09	1.09	1.04	1.07
	Av.	1.06	1.08	1.13	1.07	1.08	1.13	1.03	1.11	1.07	1.09	1.09	1.08	1.08	1.05	1.08
Work required to break in transverse test*	1	6200	6400	7500	6600	6700	6400	6400	6200	5000	6000	5800	6300	5900	5500	5900
	2	5100	5900	4400	6700	5500	4800	6000	5900	5700	5600	4700	3300	4300	4100	4100
	3	6100	6800	5300	7100	6300	6300	5300	6200	6100	6000	6000	6100	6800	6100	6200
	10	5800	4100	7000	6600	5900	6700	3200	5400	5000	5100	5400	6000	5900	6100	5800
	19	6300	7100	5500	6000	6200	7100	4500	6300	4400	5600	5500	7000	6100	5900	6100
	Av.	5900	6100	5900	6600	6100	6300	5100	6000	5200	5700	5500	5700	5800	5500	5600
Modulus of rupture* (lbs./sq. in.)	1	7400	7300	8500	7600	7700	7400	7600	7000	6600	7100	6800	7000	6600	6200	6600
	2	5800	6800	6300	7100	6500	5300	7000	6700	6400	6300	5800	5800	6500	5700	5900
	3	7000	7900	6800	8600	7600	7200	6000	7000	6900	6800	6700	7000	7100	6800	6900
	10	6500	7800	7800	7700	7500	6800	4900	5900	5300	5700	5900	6800	6600	7100	6600
	19	7400	8000	7500	9000	8000	6800	6700	7300	5700	6600	6100	7300	6800	6600	6700
	Av.	6800	7600	7400	8000	7500	6700	6400	6800	6200	6500	6300	6800	6700	6500	6600
Pliability* (in.)	1	0.013	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.012	0.014	0.014	0.014	0.014	0.014	0.014
	2	0.014	0.014	0.011	0.012	0.013	0.015	0.014	0.014	0.014	0.014	0.013	0.009	0.010	0.011	0.011
	3	0.014	0.014	0.013	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.015	0.014	0.014
	10	0.014	0.009	0.015	0.014	0.013	0.015	0.010	0.014	0.015	0.013	0.014	0.014	0.014	0.014	0.014
	19	0.013	0.014	0.012	0.011	0.012	0.017	0.011	0.014	0.012	0.013	0.014	0.015	0.014	0.014	0.014
	Av.	0.014	0.012	0.013	0.013	0.013	0.015	0.013	0.014	0.013	0.014	0.014	0.013	0.013	0.013	0.013

* See footnotes to Table XIX.
† See footnotes to Table XV.

(4) Constitution of Vitreous Bodies Determined by Petrographic Means

Three vitreous bodies made with the soda feldspar (No. 1), a low potash feldspar (No. 2), and a high potash feldspar (No. 19), fired to cone 12 in 30 hours, were examined with a polarizing microscope.

In these three bodies, the mullite was well developed and the quartz showed evidence of solution, being surrounded by narrow solution rims. Since there was no appreciable difference between the mullite development or the amount of quartz solution produced by the three different feldspars, it was not thought that examination of the other bodies would be justified.

(5) Effect of Feldspar on Relative "Glaze Fit"

Five series of tests, three on vitreous bodies and two on semivitreous bodies, were made to determine, if possible, the resistance to crazing of bodies and glazes containing the several feldspars as the only variable

TABLE XXI

VITREOUS BODIES (SEE TABLE XII) AND GLAZE COMBINATIONS USED IN FIRST SERIES OF QUENCHING TESTS

Group		Total number of specimens
1	Each body (Nos. 1–19) with glaze containing the same feldspar as in body	95
2	Body 1 and glazes Nos. 17, 18, and 19	15
3	" 2 " " " " " " "	15
4	" 3 " " " " " " "	15
5	" 17 " " " 1 2 " 3	15
6	" 18 " " " " " " "	15
7	" 19 " " " " " " "	15

TABLE XXII

VITREOUS BODIES AND GLAZE COMBINATIONS USED IN SECOND SERIES OF QUENCHING TESTS

Group		Total number of specimens
1*	Each body (1–19) with the glaze containing the same feldspar as in body	95
2	Body 1 and glazes 1, 2, 3, 10, 18, and 19	30
3	" 2 " " " " " " " " "	30
4	" 3 " " " " " " " " "	30
5	" 10 " " " " " " " " "	30
6	" 18 " " " " " " " " "	30
7	" 19 " " " " " " " " "	30

*In the third series of quenching tests Group 1 was not included.

component. The test pieces were disks 3 inches by $^1/_4$ inch, glazed on both sides. Five specimens of each combination of body and glaze were made for each series of tests. The vitreous bodies were "bisqued" to cone 12, dipped in slip weighing 23 oz./pint, and glost fired to cone 10. The semivitreous bodies were "bisqued" to cone 8, dipped in slip weighing 24 oz./pint, glost fired to cone 6, and cooled slowly.

(a) Vitreous Bodies Ten quenchings were made from 175°C and five quenchings were made from each of the

TABLE XXIII

SEMIVITREOUS BODY AND GLAZE COMBINATIONS USED IN THE FOURTH SERIES OF QUENCHING TESTS

(Values in the table show the number of quenchings (average of five specimens) required to produce crazing)

Body Numbers	Glaze Numbers																			Av.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1	20.6									26							30	16.6	26.4	23.9
2		24								27							30	23.8	29.2	26.8
3			30							26							30	18.4	29	26.7
4				30						30										30
5					30					30										30
6						21.6				26.8										24.2
7							30			19.4										24.7
8								30		26										28
9									29.6	19.4										24.5
10	30	30	24.8	30	27	30	30	30	30	28.2	25.4	18.8	29.9	30	29.9	29.2	30	14.8	30	27.8
11										28	24.4									26.2
12										25		23								24
13										21.8			29.2							25.5
14										26.2				30						28.1
15										18.4					25.4					21.9
16										26						26.2				26.1
17	27.6	19.4	20.5							23.6							22.6			22.7
18	11.6	13.8	13.8							15.4								14		13.7
19	30	25.8	20.4							28.8									29	26.8
Av.	24	22.6	21.9	30	28.5	25.8	30	30	29.8	24.8	24.9	20.9	29.6	30	27.6	27.7	28.5	17.5	28.7	26

following temperatures, or until crazing appeared: 190°, 205°, 220°, and 235°. The specimens were heated for twenty minutes at the desired temperature and then plunged quickly into running water at 28°C. In practically every case, quenching from 220° or lower produced crazing. It must be noted, however, that these specimens were quenched as often as possible during the day and that frequently specimens were found to be crazed the next morning, although when examined the evening before they were apparently not affected.

The results with specimens of group 1 (Table XXI), obtained in the first series of quenching tests, were erratic and indicated no appreciable effect of the feldspars. The glazes failed rather uniformly after one or two quenchings from either 205 °C or 220°C. There was also no noteworthy difference in the apparent resistance to crazing of the

specimens of groups 2, 3, and 4. Specimens of groups 2 and 4 failed at 190° and 205°, while nearly every specimen of group 3 crazed after the first or second quenching from 205°. Specimens of groups 5, 6, and 7 were very poor as to resistance to crazing. In fact, the majority of the specimens were crazed on removal from the kiln.

The second series of tests was made using combinations of vitreous bodies and glazes as shown in Table XXII. The crazing tests involved a total of fifty quenchings from 200°C to running water. In this test and in succeeding tests any particular specimen was quenched only once per day in order to obviate the "over-night" crazing mentioned under series 1. The second series did not craze sufficiently to give any conclusive results and, since these results were radically different from those obtained in the first series, the test was repeated using an entirely new series of specimens except for group 1 (Table XXII), which was not included. The results obtained in the third series of tests were as erratic as those of the second series and do not warrant publication.

(b) Semivitreous Bodies Series IV and V of the crazing tests contained the groups of semivitreous bodies and glazes shown in Tables XXIII and XXIV, respectively. The specimens of these two series were quenched as described for Series II, except

TABLE XXIV

SEMIVITREOUS BODY AND GLAZE COMBINATIONS USED IN THE FIFTH SERIES OF QUENCHING TESTS

(Values in the Table Show the Number of Quenchings (Average of 5 Specimens) Required to Produce Crazing)

	Glaze Number						
Body Number	1	2	3	10	18	19	Av.
1	20.8	30.0	12.2	23.2	25	20.2	21.9
2	29.4	28.2	27.0	30.0	23.6	22.4	26.8
3	26.8	19.2	10.8	23.2	15.4	22.2	19.6
10	24.6	16.0	10.0	14.4	25.0	14.0	17.3
18	29.8	22.4	20.2	26.6	20.8	22.8	23.8
19	10.4	19.2	5.6	12.6	5.0	15.6	11.4
Av.	23.6	22.5	14.3	21.7	19.1	19.5	

that a total of thirty (instead of fifty) quenchings was made. The values in the tables show the number of quenchings (average for five specimens of each body-glaze combination) required to produce crazing.

The results obtained were too erratic to justify any definite conclusions concerning the effect of different feldspars on the glaze fit of semivitreous bodies.

(6) Thermal Expansions of Five Bodies; Effect of Method of Firing

The thermal expansion was observed on vitreous (Bureau formula) and semivitreous (both Bureau and Committee formula) bodies containing

five different feldspars, respectively (feldspars 1, 2, 3, 10, and 19). Triangular specimens were hand-pressed, fired according to the four combinations of fast and slow heating and cooling, as described in the footnote to Table XV, and the expansions observed by the interferometer method previously referred to (see footnote 17).

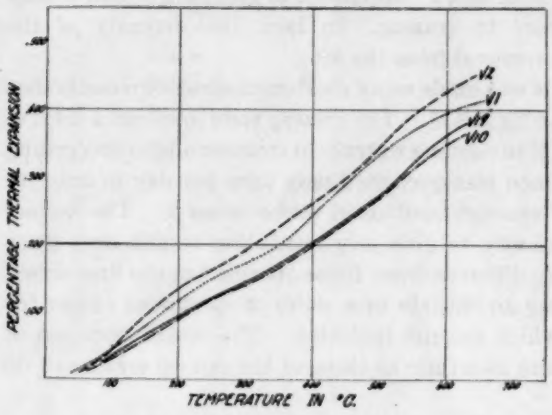

FIG. 7.—Curves showing linear thermal expansions of vitreous bodies Nos. 1, 2, 10, and 19 fired to cone 12 in 30 hours and cooled at an average rate of 16° per hour.

Curves showing the percentage linear thermal expansion of bodies V1, V2, V10, and V19, fired to cone 12 in 30 hours and cooled at an average rate of 16°C per hour, are shown in Fig. 7. Curves showing percentage linear thermal expansion of bodies SV1, SV2, SV10, and SV19, fired to cone 8 in 30 hours and cooled at an average rate of 19°C per hour, are shown in Fig. 8. Curves showing the effect of the four methods of firing on the percentage linear thermal expansions of bodies V10, SV10C and SV1C are shown in Figs. 9, 10, and 11. The information obtained is condensed in Table XXV.[31]

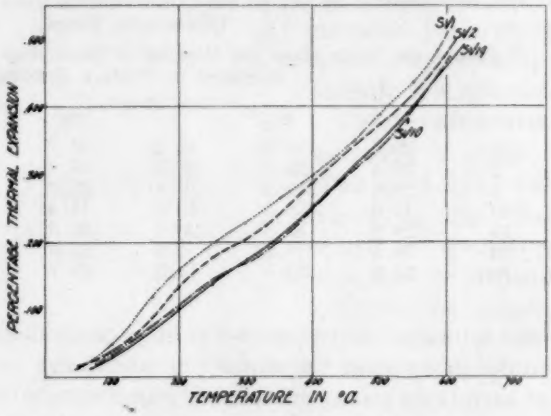

FIG. 8.—Curves showing percentage linear thermal expansions of semivitreous bodies Nos. 1, 2, 10, and 19 (Bureau formula), fired to cone 8 in 30 hours and cooled at an average rate of 19°C per hour.

The average expansions of the vitreous

[31] For other data and references on the effect of various heat treatments see *Trans. Amer. Ceram. Soc.*, **13**, 406, 431 (1911); *Ber. deut. keram. Ges.*, **13** [6], 1 (1922); and A. B. Searle, The Chemistry and Physics of Clays and Other Ceramic Materials (Ernest Benn, Ltd., London).

bodies are considerably lower than those of the semivitreous bodies (average difference of 0.061% at 600°C). This statement holds without exception for the expansions observed at 600°C, but there are exceptions at the lower temperatures, as the values in Table XXV show. The values for the vitreous bodies also show that the bodies containing the feldspars of highest soda content (V1 and V2) have the highest expansions and that, with four exceptions, body V2 (containing a feldspar of both high soda and high uncombined silica content) has the highest expansion for all methods of firing and at the three temperatures given in the table. There were no characteristic effects noted for the four methods of heat treatment. Typical curves are shown in Figs. 7 and 9.

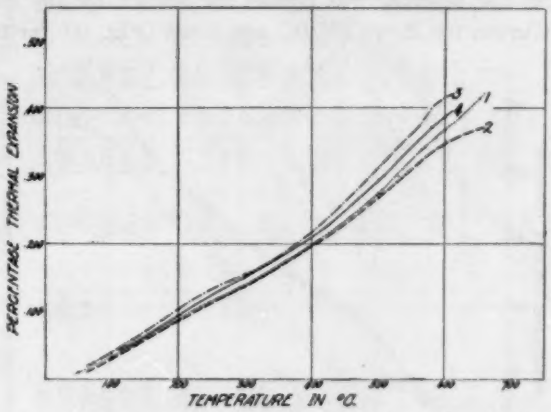

FIG. 9.—Percentage linear thermal expansion of body V10 showing the effect of four different heat treatments. (For explanation of the heat treatments see footnote to Table XV.)

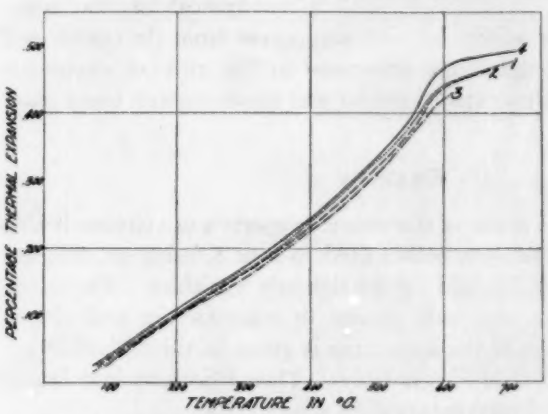

FIG. 10—Percentage linear thermal expansions of body SV10C showing the effect of four different heat treatments. (For explanation of the heat treatments see footnote to Table XV.)

The values obtained for the semivitreous bodies show rather well-defined effects of both the feldspar and the heat treatment used. With few exceptions (mostly for heat treatment No. 1, slow heat and fast cool) bodies SV1 and SV1C showed the highest expansion. The lowest expansion was shown by body SV19C for the "Committee formula" group of bodies, while bodies SV10 and SV19 showed the lower, and very nearly identical, average expansions for the group of bodies made

according to the "Bureau formula." Typical curves are given in Fig. 8. The effects of the various heat treatments (see footnote to Table XV) on the semivitreous bodies are shown by the curves in Figs. 10 and 11. Curves for Body SV10C are given (Fig. 10) for two reasons: (1) because the feldspar used is intermediate in composition, as to the Na_2O-K_2O ratio and the percentage of uncombined silica; (2) because the values for this body were the one exception to the general trend indicating that the slow cooling of semivitreous bodies (heat treatments 2 and 4, see Table XXV) produces the highest expansion irrespective of the rate of heating. Curves typical of the semivitreous bodies are shown in Fig. 11. It is apparent from the curves and the data that the only significant difference in the rate of expansion between semivitreous bodies rapidly cooled and slowly cooled takes place below 250°C.

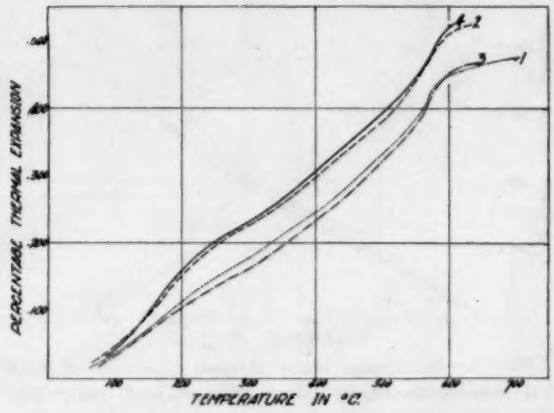

FIG. 11.—Percentage linear thermal expansion of body SV1C showing the effect of four different heat treatments. These curves are typical of the average tendencies shown by the semivitreous bodies. (For explanation of the heat treatments see footnote to Table XV.)

(7) Elasticity

Some observations were made of the elastic properties of vitreous bodies fired to cone 12 and semivitreous bodies fired to cone 8, using six different feldspars (Nos. 1, 2, 3, 10, 18, and 19) as the only variables. The specimens were approximately one inch square in cross-section and eleven inches long. A description of the apparatus is given in the "Third Progress Report on Investigation of Sagger Clays: Their Elasticity and Transverse Strength at Several Temperatures."[32]

The modulus of elasticity was computed in the usual manner according to the following equation as applied to bars of rectangular cross-section when the load is applied at the center of the beam:

$$E = \frac{PL^3}{4 \times \Delta \times bd^3}$$

[32] *Jour. Amer. Ceram. Soc.*, **10** [7], 524 (1927).

TABLE XXV

PERCENTAGE LINEAR THERMAL EXPANSION OF BODIES

Body No.†	At 250°C Heat Treatment* 1	2	3	4	Av.	At 560°C Heat Treatment* 1	2	3	4	Av.	At 600°C Heat Treatment* 1	2	3	4	Av.
V1	0.146	0.144	0.132	0.152	0.143	0.370	0.364	0.381	0.366	0.370	0.408	0.394	0.428	0.412	0.410
V2	0.154	0.168	0.140	0.156	0.154	0.366	0.397	0.358	0.390	0.378	0.398	0.428	0.400	0.426	0.413
V3	0.136	0.136	0.130	0.124	0.132	0.366	0.350	0.341	0.358	0.354	0.408	0.390	0.390	0.404	0.398
V10	0.118	0.116	0.130	0.128	0.123	0.335	0.318	0.375	0.350	0.345	0.372	0.348	0.418	0.386	0.381
V19	0.116	0.120	0.139	0.130	0.126	0.328	0.323	0.394	0.350	0.349	0.370	0.366	0.440	0.396	0.393
Av.	0.134	0.137	0.134	0.138	0.136	0.353	0.350	0.370	0.363	0.359	0.391	0.385	0.417	0.405	0.400
SV1	0.128	0.200	0.140	0.214	0.170	0.376	0.449	0.407	0.488	0.430	0.426	0.508	0.461	0.548	0.486
SV2	0.146	0.178	0.138	0.202	0.166	0.406	0.440	0.392	0.464	0.425	0.466	0.488	0.440	0.528	0.480
SV3	0.146	0.152	0.124	0.162	0.146	0.409	0.417	0.370	0.449	0.411	0.460	0.468	0.440	0.504	0.468
SV10	0.130	0.144	0.142	0.146	0.140	0.371	0.416	0.373	0.422	0.395	0.432	0.476	0.476	0.480	0.466
SV19	0.138	0.140	0.140	0.138	0.139	0.404	0.420	0.386	0.404	0.404	0.462	0.486	0.442	0.464	0.463
Av.	0.138	0.163	0.137	0.172	0.152	0.393	0.428	0.385	0.445	0.413	0.449	0.485	0.452	0.505	0.473
SV1C	0.148	0.190	0.138	0.200	0.169	0.397	0.452	0.394	0.455	0.425	0.456	0.506	0.450	0.520	0.483
SV2C	0.138	0.174	0.136	0.137	0.146	0.403	0.424	0.401	0.398	0.406	0.480	0.482	0.464	0.450	0.469
SV3C	0.140	0.152	0.133	0.166	0.148	0.415	0.400	0.383	0.435	0.408	0.460	0.452	0.432	0.498	0.460
SV10C	0.136	0.136	0.130	0.144	0.136	0.392	0.387	0.370	0.415	0.391	0.438	0.444	0.424	0.470	0.444
SV19C		0.128	0.116	0.134	0.126		0.380	0.360	0.385	0.375		0.440	0.428	0.444	0.437
Av.	0.140	0.156	0.131	0.156	0.145	0.402	0.408	0.381	0.417	0.401	0.458	0.465	0.440	0.476	0.459

* For details of heat treatments, see footnote, Table XV.

† V: vitreous (Bureau formula).
SV: semivitreous (Bureau formula).
SVC: semivitreous (Committee formula).

TABLE XXVI

MODULUS OF ELASTICITY

(lbs. per sq. in.)

	1	2	3	10	18	19	Av.	Min. value variation from av. (%)	Max. value variation from av. (%)
Vitreous	11,500,000	11,600,000	12,200,000	11,600,000	11,400,000	11,300,000	11,600,000	2.58	5.16
Semivitreous	7,900,000	6,690,000	7,500,000		7,400,000	6,460,000	7,190,000	10.15	9.87

Where

E = modulus of elasticity
P = load at any convenient deflection
Δ = deflection at load (P) taken from stress-strain diagram
b = breadth
d = depth
L = span (10 inches)

The observations were made at room temperature only and on two specimens of each body. Results are shown in Table XXVI. The average maximum elongation of extreme fiber[33] for vitreous bodies was found to be 0.000499 inch and for semivitreous bodies 0.000648 inch. The average modulus of elasticity for vitreous bodies was found to be 11,600,000 lbs./sq. in. and for semivitreous bodies was 7,190,000 lbs./sq. in. These values show, therefore, that the average modulus of elasticity of the vitreous bodies fired to cone 12 is approximately 60% greater than that of the semivitreous bodies fired to cone 8. Since check determinations gave similar results (Table XXVI), it is not apparent that the different feldspars used had any appreciable effect upon the elasticity of a pottery body.

VI. Summary and Conclusions

Following an outline of the general study of whiteware raw materials of which this investigation of feldspar forms a part, results are given of the following tests on nineteen feldspars: screen analyses, air elutriation, chemical analyses, softening range, softening point (P.C.E. values), true specific gravity, thermal expansion, and petrographic analyses. Results are also given of the following tests on whiteware bodies in which the feldspars were the only variable component: firing behavior, color, translucency, mechanical strength, petrographic analyses, "glaze fit," thermal expansion, and elasticity. The results may be summarized as follows:

(1) The residue of the commercial ground feldspars investigated varied approximately from 0 to 7% on the No. 200 sieve; on the No. 325 sieve from 3 to 15%, and by air elutriation (0.02 mm. separation) from 32 to 55%.

(2) The variation in screen analyses made independently by various laboratories differed sufficiently to indicate that specifications for fineness closer than ± 0.5% would have little significance.

(3) Differences in chemical analyses indicate the need for greater care in analysis.

[33] The maximum elongation of extreme fiber is the elongation at midspan on the lower surface of the specimen under maximum stress. If the load-deflection relation is a straight line up to the point of rupture, the modulus of elasticity is constant and the value for maximum elongation of fiber (per unit length) is equal to modulus of rupture divided by the modulus of elasticity. This statement is based on the assumption that the modulus of elasticity in tension and in compression are equal and in the calculations the effect of shearing deformation was neglected since, with specimens of the type under consideration, these would be insignificant.

(4) The results indicate that refractoriness increases, and the softening range decreases, with increase in K_2O.

(5) The softening points (P.C.E. values) range from cone 4 for soda feldspar to cones 9 to 10 for potash feldspar, and the results indicate that average variations of one cone can be expected in the results of different laboratories, particularly when no single method is followed by all.

(6) "True" specific gravity of the crystalline feldspars investigated ranged from 2.628 $\frac{(30°C)}{(20°C)}$ for the feldspar highest in soda to 2.565 $\frac{(30°C)}{(20°C)}$ for the feldspar highest in potash.

(7) The density of feldspar decreases as the temperature to which it is fired is increased within the range used in this study.

(8) The thermal expansion of the feldspars fired at cone 4 (Nos. 1, 2, and 3) is low as compared with those fired at cones 8, 10, and 12 and drops again for those feldspars (Nos. 4 to 19, inclusive) fired to cones 13 and 14. The expansion apparently is affected by the Na_2O–K_2O ratio and by the percentage of uncombined silica. The latter appears to be the dominating factor, but its influence decreases as the temperature to which the feldspar is fired is increased.

(9) Petrographic analyses of the crystalline feldspars showed the samples to vary from commercially pure soda feldspar (No. 1) to commercially pure potash feldspar (No. 19). The content of uncombined silica varied from 26.7% (No. 7) to 0.8% (No. 18). Examination of partially and completely fused specimens of six feldspars (Nos. 1, 2, 3, 10, 18, and 19) indicated that the K_2O–Na_2O ratio had no measurable effect on the rate of quartz solution.

(10) The type of feldspar used has no discernible effect on the firing behavior of the body or on the color by reflected light.

(11) The translucency of vitreous bodies increased (body No. 1 excepted) with increase in the K_2O content of the feldspar used.

(12) The mechanical strength is influenced more by the heat treatment and manner of forming the specimens than by the kind of feldspar used.

(13) Petrographic examination of vitreous bodies V1, V2, and V19 showed no appreciable differences in mullite development or solution of quartz.

(14) Quenching tests do not appear to indicate the relative merits of the feldspars regarding relative "glaze fit."

(15) The thermal expansion of both vitreous and semivitreous bodies was highest for those containing the high soda feldspars and the semivitreous bodies which were cooled slowly showed the highest average expansions irrespective of the rate of heating.

(16) The kind of feldspar used does not have a measurable effect upon the elasticity of the body containing it.

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THE EFFECT OF HYDROGEN-ION CONCENTRATION UPON THE SEDIMENTATION OF CLAY[1]

By Norvil Beeman

ABSTRACT

The addition of an acid to a clay suspension usually causes rapid sedimentation, while the addition of a base reverses the process. This is generally explained by saying that clay is a negative colloid and hence flocculated or precipitated by the hydrogen ions of the acid and for the same reason deflocculated by the base. These experiments showed that the effect of hydrogen-ion concentration upon the rate of sedimentation[2] was relatively great and explains why changes in the p_H values produce such noticeable changes in plasticity and viscosity. They show also that elutriation is an uncertain process without p_H control.

Introduction

The Apparatus The rate of sedimentation was measured by determining the rate of change in density during sedimentation by means of a plummet hanging from a balance arm and immersed in the suspension.[3] A Becker "chainomatic" balance was used because of the advantage it offered through its chain attachment and vernier scale for quick and accurate weighing. The plummet, made of glass tubing partially filled with mercury, was attached to a fine platinum wire which passed up from the sedimentation vessel below through the shelf of reënforced concrete upon which the balance was mounted, and through a small hole in the balance base to the left pan of the balance where it was attached. A counterpoise for use upon the right pan was made from glass tubing mercury filled and sealed. The platinum wire was electrolytically given a coating of "platinum black" along a distance of two or three centimeters where it entered the suspension. This coating greatly increased the sensitivity of the balance.[4] The suspensions were made up in a 1000-cc. glass-stoppered graduated cylinder, this same cylinder

[1] Read before the Chemistry and Geology Section of the conference held at Yenching University, Peking, China, at the occasion of the formal opening of that Institution, Sept., 1929. Received August 11, 1930.

[2] For references to the various forms of apparatus for determining rates of sedimentation and particle size such a book as Holmes' Manual of Colloid Chemistry may be consulted, or The Svedberg's Colloid Chemistry, or the Colloid Symposium Monographs, published annually by the Chemical Catalogue Company. A brief review of the simpler pieces of apparatus, together with a new modification, was given by the author in a paper read at the occasion of the opening of the science building at Lingnan University, Canton, in October, 1928 (to be published).

[3] The names of two former students should be mentioned in connection with this work: Wei Chen, now a graduate student at Oberlin College, Oberlin, Ohio, and W. H. Yu who has just entered Peking Union Medical College. The work here reported upon was not done by them but they deserve credit for considerable preliminary work with the clay and sedimentation apparatus.

[4] See the chapter on density determinations in Reilly's Physico-Chemical Methods, D. Van Nostrand Co.

serving also as the sedimentation vessel. The weights and the counterpoise were carefully calibrated and the volume of the plummet determined by weighing it in the air and in freshly distilled water. The "height of fall" was taken as the distance from the surface of the suspension to the midpoint of the plummet. The experiments reported here were carried out during some spring and summer rains of several days' duration and it was no difficult matter to find periods of time over which there was almost no change of temperature, or so little as to be controllable by the doors and windows of the room. Had it been otherwise, a constant temperature bath would have been a necessity.

The weight in air of the plummet, the platinum wire, and the means of its attachment to the left pan of the balance was 49.6847 grams. The weight of that part of the wire and the attachment above the surface of the suspension in the sedimentation cylinder was 0.8020 gram. The weight in air of the plummet and that portion of the wire, which during a sedimentation experiment, lay below the surface was 48.8827 grams, and the volume of this portion below the surface was found to be 10.6682 cc. These data were sufficient, together with the weights placed upon the right pan of the balance, for the calculation of the density and hence of the percentage sedimentation at any moment. Another method, the one employed in the tables below, was to calculate the weight at zero time and at the time of complete sedimentation, and from their differences (which was the change for the complete sedimentation of the clay) the percentage sedimentation at any instant was readily calculated.

The Clay The clay for this work was a white variety secured from Sharp Peak, an island at the mouth of the Min River below Foochow. It was slaked down, put into suspension by shaking, and the smaller particles separated for use by siphoning off portions of the suspension after standing an arbitrary period of time. The clay was recovered from these portions by evaporation over water baths. The portions were then combined, thoroughly mixed, and placed in glass-stoppered bottles.

The density of the clay was determined by the pycnometer method using kerosene for one set of determinations and distilled water for the other. As was to be expected, the two liquids gave slightly different results, so the density taken for these calculations was that obtained with the use of water, *viz.*, 2.711.

Constants and Corrections (1) Density of water: the "absolute density," *i.e.*, density in grams per cubic centimeter.[5]

(2) Density of solutions: These were determined experimentally by means of the balance and the plummet.

[5] Handbook of Chemistry and Physics, Chemical Rubber Company, Cleveland, Ohio.

(3) Correction in density for presence of air due to shaking: Since the clay was always put into suspension by shaking, the solution became mixed with air. This correction was determined experimentally for the period of time required for proper mixing of the clay and for the cylinder in which the suspensions were always mixed. Several determinations showed an average difference in weight of the immersed plummet due to mixing with air of 0.00273 gram. Since the volume of the plummet was 10.6682 cc. this was equivalent to a difference in density of 0.000256.

(4) Viscosity of water and solutions: For the water an average was taken of the values published in the Physical Tables of the Smithsonian Institute. The viscosities of the sodium hydroxide and hydrochloric acid solutions were obtained by extrapolation and interpolation in the tables on pages 12 and 15, Vol. V, International Critical Tables.

(5) Gravitational Constant: The Physics Department of Fukien Christian University found this to be 979.2 for Foochow, China.

(6) Density of the clay: 2.711 as described above.

(7) Height of fall during sedimentation: From the surface of the suspension to the midpoint of the plummet, the distance was 25 cm. except in the one or two cases noted. This height was constant throughout an experiment because the pointer of the balance was maintained at the middle of the scale by the "chainomatic" device of the balance. That is, the readings recorded were not deviations of the pointer from the zero position, which would have increased the height of fall, but were taken with the pointer at zero and directly from the vernier scale in grams.

(8) Correction for the clay deposit upon the plummet: During sedimentation, in spite of the steep slope given the sides of the plummet, clay would deposit in a thin layer, thus increasing the weight. This difficulty was met by removing the plummet in a few trial sedimentations, washing it free from clay, and immersing it again. The average difference in weight was found to be slightly less than 0.0028 gram for complete sedimentation at the concentration of clay used. This was the most unsatisfactory of all the corrections because deposits were found to adhere less firmly in some instances than others, depending apparently upon the hydrogen-ion concentration of the solution in some way. But even so, results show that this factor so determined must have been a close approximation to fact.

The Determination

In carrying out a determination, the balance was made ready by placing upon the right pan the weights (or counterpoise) necessary to balance the plummet when immersed to the proper depth in the suspension. A little experience made one quite expert at this. Fifteen grams of clay were weighed out in the cylinder and distilled water, or solution, added to make the proper volume. In most of these determinations the total volume was exactly 1000 cc. with the plummet in place. The cylinder was closed with its glass stopper and shaken thoroughly for a period of three minutes. Immediately upon turning it upright the stop-watch was started, the

stopper removed, and as soon thereafter as possible the plummet immersed to the proper depth, the cylinder put into place under the balance shelf, and the plummet attached to the left pan of the balance. The balance pan arrests were then lowered and the pointer brought to the midpoint of the scale by means of the "chainomatic" device. All of this, from the time the stop-watch was started, seldom consumed more than three minutes and often required even less. After this it was a simple matter to keep the pointer at zero and to take the readings.

To calculate the weight on the balance at the very beginning of sedimentation, that is, at zero time, substitution was made in the formula:

$$\text{Wt.} = 49.6847 - 10.6682 \times \text{density of suspension}$$

To calculate the weight after complete sedimentation, indicated by ∞ time in the tables, substitution was made in the formula:

$$\text{Wt.} = 49.6847 - 10.6682 \times \text{density of solution}$$

The density of the suspension (density before sedimentation has started) is equivalent to

$$\left(\begin{matrix}\text{Wt. of clay per cc.}\\ \text{of suspension}\end{matrix}\right) + \left\{1 - \frac{15}{2.711 \times \text{vol. of suspension}}\right\} \times \begin{matrix}\text{density of}\\ \text{solution}\end{matrix}$$

These calculations were carried out with sufficient care to insure the reliability of the result to the fourth decimal place. The sensitivity of the balance fully warranted this for with water and homogeneous solutions the density could be determined repeatedly with an accuracy of ± 0.00005. All other calculations were performed on a 20 cm. slide rule. The effort was to give the figures in the first two columns (see tabulated data below), *i.e.*, the time and the weight columns, as great an accuracy as the apparatus permitted so that if some better method were found later for taking care of the deposit correction the sedimentation experiments would not need to be repeated.

Let Determination I illustrate. In the first column appears the time in minutes, in the second column the weight on the right balance pan, in the third the change in weight from zero time, in the fifth the corrected change after the deposit of clay upon the plummet had been taken into account, and in the sixth column the percentage sedimentation. The figures in the last column were obtained by substituting in the familiar Stoke's formula:

$$r = \sqrt{\frac{9}{2}\frac{\eta}{(\Delta - \delta)g}\frac{h}{t}}$$

r = effective radius of particle
η = viscosity
Δ = density of clay
δ = density of solution
g = gravitational constant
h = height of fall
t = time in seconds

From the data in the last two columns, the corresponding curve in Fig. 1 was drawn.

Determination I

15 g. of clay in 989.3 cc. of 0.0969 *N* HCl
T = 27.9°C Density of solution mixed with air = 0.99776
Viscosity = 0.00847 Height of fall = 25 cm.

Time (Min.)	Wts. on Balance	Change from 0 Time	Correction for Deposit	Corrected Change from 0 Time	Sedimentation (%)	r in Microns
0.0	38.9382					
3.5	38.9403	0.0021	0.0001	0.0020	2.0	16.4
6.5	38.9986	0.0604	0.0016	0.0588	57.5	12.1
11.0	39.0394	0.1012	0.0027	0.0985	96.4	9.3
15.0	39.0413	0.1031	0.0027	0.1004	98.2	7.9
18.0	39.0419	0.1037	0.0028	0.1009	98.7	7.2
25.0	39.0427	0.1045	0.0028	0.1017	99.5	6.1
∞	39.0404	0.1022			100.0	

Determination II

15 g. of clay in 989.3 cc. of 0.0484 *N* HCl
T = 28.2°C Density of solution mixed with air = 0.99680
Viscosity = 0.00838 Height of fall = 25 cm.

Time (Min.)	Wts. on Balance	Change from 0 Time	Correction for Deposit	Corrected Change from 0 Time	Sedimentation (%)	r in Microns
0.0	38.9483					
3.0	38.9491	0.0008	0.0000	0.0008	0.8	17.7
4.0	38.9541	0.0058	0.0002	0.0056	5.5	15.3
5.0	38.9731	0.0248	0.0007	0.0241	23.5	13.7
7.0	39.0427	0.0944	0.0025	0.0919	89.8	11.5
9.0	39.0487	0.1004	0.0027	0.0977	95.5	10.2
11.0	39.0502	0.1019	0.0027	0.0992	97.0	9.2
16.0	39.0516	0.1033	0.0028	0.1005	98.3	7.7
36.0	39.0532	0.1049	0.0028	0.1021	99.8	5.1
∞	39.0506	0.1023			100.0	

Duplicate of Determination II

0.0	38.9483					
3.0	38.9499	0.0016	0.0000	0.0016	1.6	17.7
5.0	38.9693	0.0210	0.0006	0.0204	19.9	13.6
7.0	39.0400	0.0917	0.0025	0.0892	87.2	11.5
9.5	39.0490	0.1007	0.0027	0.0980	95.8	9.9
15.0	39.0512	0.1029	0.0028	0.1001	97.8	7.9
33.0	39.0525	0.1042	0.0028	0.1014	99.0	5.3
248.0	39.0536	0.1053	0.0028	0.1025	100.2	1.9
∞	39.0506	0.1023			100.0	

Determination III

15 g. of clay in 989.3 cc. of 0.0097 *N* HCl

T = 29.2°C Density of solution mixed with air = 0.99580

Viscosity = 0.00818 Height of fall = 25 cm.

Time (Min.)	Wts. on Balance	Change from 0 Time	Correction for Deposit	Corrected Change from 0 Time	Sedimentation (%)	r in Microns
0.0	38.9590					
2.5	38.9600	0.0010	0.0000	0.0010	1.0	19.1
4.0	38.9753	0.0163	0.0004	0.0159	15.5	15.1
7.0	39.0571	0.0981	0.0026	0.0955	93.3	11.4
9.5	39.0594	0.1004	0.0027	0.0977	95.5	9.8
18.0	39.0605	0.1015	0.0027	0.0988	96.6	7.1
33.0	39.0618	0.1028	0.0028	0.1000	97.7	5.3
∞	39.0613	0.1023			100.0	

Duplicate of Determination III

0.0	38.9590					
2.5	38.9589	−0.0001	0.0000	−0.0001		19.1
6.0	39.0510	0.0920	0.0025	0.0895	87.5	12.3
8.0	39.0578	0.0988	0.0027	0.0961	93.9	10.7
14.0	39.0608	0.1018	0.0027	0.0991	96.8	8.1
21.0	39.0617	0.1027	0.0028	0.0999	97.6	6.6
25.0	39.0619	0.1029	0.0028	0.1001	97.8	6.0
34.0	39.0620	0.1030	0.0028	0.1002	97.9	5.2
∞	39.0613	0.1023			100.0	

Determination IV

15 g. of clay in 994.3 cc. of 0.0048 *N* HCl

T = 29.2°C Density of solution mixed with air = 0.99572

Viscosity = 0.00817 Height of fall = 25 cm.

Time (Min.)	Wts. on Balance	Change from 0 Time	Correction for Deposit	Corrected Change from 0 Time	Sedimentation (%)	r in Microns
0.0	38.9603					
2.5	38.9611	0.0008	0.0000	0.0008	0.8	19.1
3.5	38.9661	0.0058	0.0001	0.0057	5.6	16.1
5.5	39.0425	0.0822	0.0022	0.0800	78.5	12.9
6.5	39.0573	0.0970	0.0026	0.0944	92.7	11.8
8.0	39.0592	0.0989	0.0027	0.0962	94.4	10.7
11.0	39.0605	0.1002	0.0027	0.0975	95.7	9.1
14.0	39.0615	0.1012	0.0027	0.0985	96.7	8.1
19.0	39.0617	0.1014	0.0027	0.0987	96.9	6.9
25.0	39.0620	0.1017	0.0027	0.0990	97.2	6.0
∞	39.0622	0.1019			100.0	

Determination V

15 g. of clay in 989.3 cc. of 0.00097 *N* HCl

T = 29.2°C Density of solution mixed with air = 0.99565

Viscosity = 0.00817 Height of fall = 25 cm.

Time (Min.)	Wts. on Balance	Change from 0 Time	Correction for Deposit	Corrected Change from 0 Time	Sedimentation (%)	r in Microns
0.0	38.9605					
2.5	38.9624	0.0019	0.0000	0.0019	1.9	19.1
4.0	38.9773	0.0168	0.0005	0.0163	15.9	15.1
6.5	39.0553	0.0948	0.0025	0.0923	90.2	11.8
8.0	39.0569	0.0964	0.0026	0.0938	91.6	10.7
10.0	39.0578	0.0973	0.0026	0.0947	92.5	9.5
16.0	39.0597	0.0992	0.0027	0.0963	94.2	7.6
22.0	39.0603	0.0998	0.0027	0.0971	94.8	6.4
35.0	39.0613	0.1008	0.0027	0.0981	95.8	5.1
37.5	39.0615	0.1010	0.0027	0.0983	96.0	4.9
46.0	39.0622	0.1017	0.0027	0.0990	96.7	4.4
∞	39.0629	0.1024			100.0	

Determination VI

15 g. of clay in 989.3 cc. of 0.00048 *N* HCl

T = 28.7°C Density of solution mixed with air = 0.99578

Viscosity = 0.00824 Height of fall = 25 cm.

Sedimentation at the time of last reading by evaporation method = 95.29%

Time (Min.)	Wts. on Balance	Change from 0 Time	Correction for Deposit	Corrected Change from 0 Time	Sedimentation (%)	r in Microns
0.0	38.9592					
2.0	38.9631	0.0039	0.0001	0.0038	3.7	21.4
3.0	38.9633	0.0041	0.0001	0.0040	3.9	17.5
4.0	38.9678	0.0086	0.0002	0.0084	8.2	15.2
6.0	39.0136	0.0544	0.0015	0.0529	51.7	12.4
8.0	39.0465	0.0873	0.0023	0.0850	83.0	10.7
10.0	39.0495	0.0903	0.0024	0.0879	85.8	9.6
11.5	39.0514	0.0922	0.0025	0.0897	87.6	8.9
15.0	39.0539	0.0947	0.0025	0.0922	90.0	7.8
22.0	39.0552	0.0960	0.0026	0.0934	91.2	6.5
40.0	39.0582	0.0990	0.0027	0.0963	94.0	4.8
42.0	39.0588	0.0996	0.0027	0.0969	94.6	4.7
76.0	39.0613	0.1021	0.0027	0.0994	97.0	3.5
∞	39.0616	0.1024			100.0	

Duplicate of Determination VI

15 g. of clay in 989.3 cc. of 0.00048 *N* HCl

T = 28.6°C Density of solution mixed with air = 0.99581

Viscosity = 0.00827 Height of fall = 25 cm.

Time (Min.)	Wts. on Balance	Change from 0 Time	Correction for Deposit	Corrected Change from 0 Time	Sedimentation (%)	r in Microns
0.0	38.9588					
2.0	38.9621	0.0033	0.0001	0.0032	3.1	21.4
2.5	38.9615	0.0027	0.0001	0.0026	2.5	19.2
3.0	38.9616	0.0028	0.0001	0.0027	2.6	17.5
4.0	38.9669	0.0081	0.0002	0.0079	7.7	15.2
10.0	39.0489	0.0901	0.0024	0.0877	85.6	9.6
11.5	39.0509	0.0921	0.0025	0.0896	87.5	8.9
15.0	39.0532	0.0944	0.0025	0.0919	89.8	7.8
20.0	39.0546	0.0958	0.0026	0.0932	91.0	6.8
∞	39.0612	0.1024			100.0	

Determination VII

15 g. of clay in 989.3 cc. of 0.000097 *N* HCl

T = 30.7°C Density of solution mixed with air = 0.99518

Viscosity = 0.00788 Height of fall = 25 cm.

Sedimentation at the time of last reading by evaporation method = 47.74%

Time (Min.)	Wts. on Balance	Change from 0 Time	Correction for Deposit	Corrected Change from 0 Time	Sedimentation (%)	r in Microns
0.0	38.9655					
2.0	38.9686	0.0031	0.0001	0.0030	2.9	20.9
3.0	38.9695	0.0040	0.0001	0.0039	3.8	17.1
4.0	38.9707	0.0052	0.0001	0.0051	5.0	14.8
5.5	38.9730	0.0075	0.0002	0.0073	7.1	12.6
8.0	38.9780	0.0125	0.0003	0.0122	11.9	10.5
10.0	38.9819	0.0164	0.0004	0.0160	15.6	9.4
12.0	38.9850	0.0195	0.0005	0.0190	18.6	8.5
15.0	38.9886	0.0231	0.0006	0.0225	22.0	7.6
20.0	38.9933	0.0278	0.0007	0.0271	26.5	6.5
30.0	38.9995	0.0340	0.0009	0.0331	32.4	5.4
46.0	39.0062	0.0407	0.0011	0.0396	38.7	4.4
60.0	39.0111	0.0456	0.0012	0.0444	43.4	3.8
75.5	39.0148	0.0493	0.0013	0.0480	46.9	3.4
∞	39.0679	0.1024			100.0	

DETERMINATION VIII

15 g. of clay in 989.3 cc. of distilled water
T = 26.7°C Density of water mixed with air = 0.99634
Viscosity = 0.00862 Height of fall = 25 cm.

Time (Min.)	Wts. on Balance	Change from 0 Time	Correction for Deposit	Corrected Change from 0 Time	Sedimentation (%)	r in Microns
0.0	38.9532					
2.0	38.9577	0.0045	0.0001	0.0044	4.3	21.9
3.0	38.9591	0.0059	0.0002	0.0057	5.6	17.9
4.0	38.9602	0.0070	0.0002	0.0068	6.6	15.5
5.0	38.9613	0.0081	0.0002	0.0079	7.7	13.8
6.0	38.9621	0.0089	0.0002	0.0087	8.5	12.7
7.0	38.9630	0.0098	0.0003	0.0095	9.3	11.7
10.0	38.9648	0.0116	0.0003	0.0113	11.0	9.8
15.0	38.9676	0.0144	0.0004	0.0140	13.7	8.0
21.0	38.9700	0.0168	0.0005	0.0163	15.9	6.8
30.0	38.9734	0.0202	0.0005	0.0197	19.3	5.7
42.0	38.9770	0.0238	0.0006	0.0232	22.7	4.8
60.0	38.9818	0.0286	0.0008	0.0278	27.2	4.0
90.0	38.9887	0.0355	0.0010	0.0345	33.7	3.3
101.0	38.9904	0.0372	0.0010	0.0362	35.4	3.1
∞	39.0555	0.1023			100.0	

DUPLICATE OF DETERMINATION VIII

15 g. of clay in 989.3 cc. of distilled water
T = 30.1°C Density of water mixed with air = 0.99536
Viscosity = 0.00800 Height of fall = 30 cm.

Time (Min.)	Wts. on Balance	Change from 0 Time	Correction for Deposit	Corrected Change from 0 Time	Sedimentation (%)	r in Microns
0.0	38.9636					
1.3	38.9662	0.0026	0.0001	0.0025	2.4	28.6
4.0	38.9700	0.0064	0.0002	0.0062	6.1	16.3
6.0	38.9722	0.0086	0.0002	0.0084	8.2	13.3
8.0	38.9739	0.0103	0.0003	0.0100	9.8	11.5
10.0	38.9753	0.0117	0.0003	0.0114	11.1	10.3
12.0	38.9766	0.0130	0.0003	0.0127	12.4	9.4
14.0	38.9777	0.0141	0.0004	0.0137	13.4	8.7
16.0	38.9786	0.0150	0.0004	0.0146	14.3	8.2
18.0	38.9794	0.0158	0.0004	0.0154	15.0	7.7
20.0	38.9804	0.0168	0.0005	0.0163	15.9	7.3
26.0	38.9824	0.0188	0.0005	0.0183	17.9	6.4
31.0	38.9841	0.0205	0.0006	0.0199	19.4	5.9
35.0	38.9854	0.0218	0.0006	0.0212	20.7	5.5
41.0	38.9868	0.0232	0.0006	0.0226	22.1	5.1
45.0	38.9880	0.0244	0.0007	0.0237	23.2	4.9
55.0	38.9909	0.0273	0.0007	0.0266	26.0	4.4
∞	39.0660	0.1024			100.0	

Discussion

Determinations I to VII, inclusive, are those in which hydrochloric acid solutions were suspension media; No. VIII had neither acid nor base; Nos. IX and X had sodium hydroxide solutions. The assumption was made that Stoke's law holds for the conditions which obtain in these experiments and that flocculation is merely the coagulation of smaller to form larger particles under the influence of the environment.

Determination IX

15 g. of clay in 989.3 cc. of 0.0011 *N* sodium hydroxide
T = 26.7°C Density of solution mixed with air = 0.99639
Viscosity = 0.00862 Height of fall = 25 cm.

Time (Min.)	Wts. on Balance	Change from 0 Time	Correction for Deposit	Corrected Change from 0 Time	Sedimentation (%)	r in Microns
0.0	38.9527					
2.0	38.9573	0.0046	0.0001	0.0045	4.4	21.9
3.0	38.9583	0.0056	0.0002	0.0054	5.3	17.9
4.0	38.9594	0.0067	0.0002	0.0065	6.4	15.5
5.0	38.9603	0.0076	0.0002	0.0074	7.2	13.8
7.0	38.9620	0.0093	0.0002	0.0091	8.9	11.7
8.0	38.9628	0.0101	0.0003	0.0098	9.6	11.0
11.0	38.9646	0.0119	0.0003	0.0116	11.3	9.4
15.0	38.9669	0.0142	0.0004	0.0138	13.5	8.0
21.0	38.9694	0.0167	0.0004	0.0163	15.9	6.8
25.0	38.9710	0.0183	0.0005	0.0178	17.4	6.2
36.0	38.9744	0.0217	0.0006	0.0211	20.6	5.2
56.0	38.9796	0.0269	0.0007	0.0262	25.6	4.2
90.0	38.9863	0.0336	0.0009	0.0327	32.0	3.3
∞	39.0550	0.1023			100.0	

Determination X

15 g. of clay in 989.3 cc. of 0.1054 *N* sodium hydroxide
T = 27.3°C Density of solution mixed with air = 1.00131
Viscosity = 0.00873 Height of fall = 25 cm.

Time (Min.)	Wts. on Balance	Change from 0 Time	Correction for Deposit	Corrected Change from 0 Time	Sedimentation (%)	r in Microns
0.0	38.9005					
2.5	38.9042	0.0037	0.0001	0.0036	3.5	19.8
4.0	38.9057	0.0052	0.0001	0.0051	5.0	15.6
5.0	38.9070	0.0065	0.0002	0.0063	6.2	14.0
6.0	38.9080	0.0075	0.0002	0.0073	7.2	12.8
7.0	38.9098	0.0093	0.0002	0.0091	8.9	11.8
8.0	38.9118	0.0113	0.0003	0.0110	10.8	11.0
10.0	38.9177	0.0172	0.0005	0.0167	16.4	9.9
13.0	38.9516	0.0511	0.0014	0.0497	48.7	8.7
14.0	38.9675	0.0670	0.0018	0.0652	63.9	8.4
16.0	38.9914	0.0909	0.0024	0.0885	86.8	7.8
18.0	38.9985	0.0980	0.0026	0.0954	93.5	7.4
20.0	39.0006	0.1001	0.0027	0.0974	95.5	7.0
28.0	39.0025	0.1020	0.0027	0.0993	97.4	5.9
75.0	39.0033	0.1028	0.0028	0.1000	98.1	3.6
∞	39.0025	0.1020			100.0	

With this assumption in mind, the curves of Fig. 1 show the following interesting features: Curve 8, representing the case in which the clay was suspended in distilled water, comes up gradually from the region of the larger radii to a very steep slope as it approaches the point of complete sedimentation. In other words, the smaller particles are in greatest abundance. Curves 1 to 6 stand out in strong contrast to this. The presence of the acid brought about the formation of particles so much larger that most of the clay was precipitated in the region of 12 to 15

microns. Curve 7 shows the effect of only a trace of acid. Here the concentration, approximately $N/10{,}000$, was insufficient to cause much change in size. From $N/10{,}000$ it is but a slight increase in actual quantity to $N/2000$ but this is sufficient to produce the profound change seen in Curve 6, showing the clay to be sensitive to small quantities of acid. The greatest flocculating effect is observed when the concentrations of acid are approximately $N/100$, $N/200$, and $N/1000$, Curves 3, 4, 5,

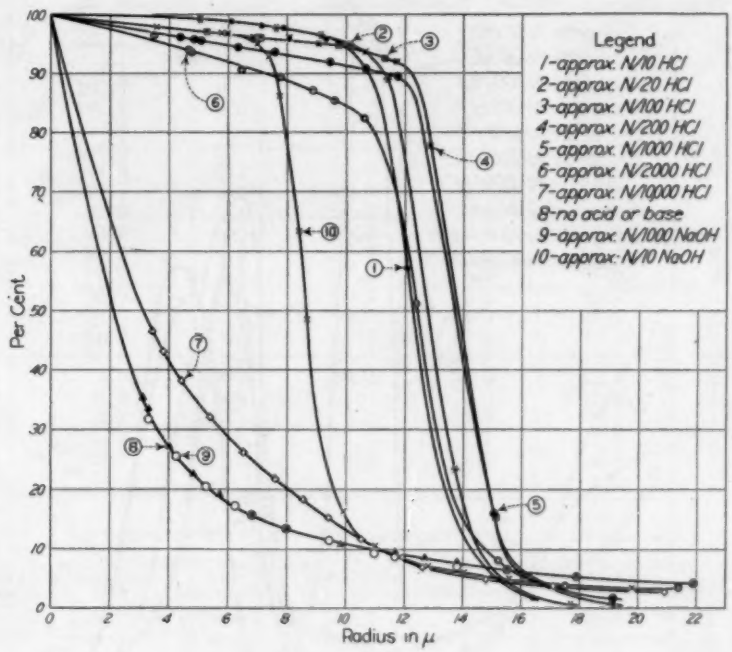

FIG. 1.

respectively. When the concentration of the acid is increased to $N/10$ it does not seem to be so effective a flocculent, or to express it differently, at this concentration the acid begins to have a deflocculating effect. This is well supported by other sedimentation experiments with higher concentrations of the acid.

Curve 9 is that of a suspension in sodium hydroxide of approximately $N/1000$. At a corresponding concentration, the acid was effective but the sodium hydroxide is without perceptible effect. Clays being in general negative colloids, this is exactly the effect to be expected. When, however,

the concentration of the base is increased to $N/10$ there is a marked flocculation, though not as marked as with $N/2000$ hydrochloric acid.[6]

Size Distribution

The following tables and Fig. 2 bring out in an even more striking way the change in size brought about by a change in the medium. Here are shown the percentage distributions for each radius interval of one

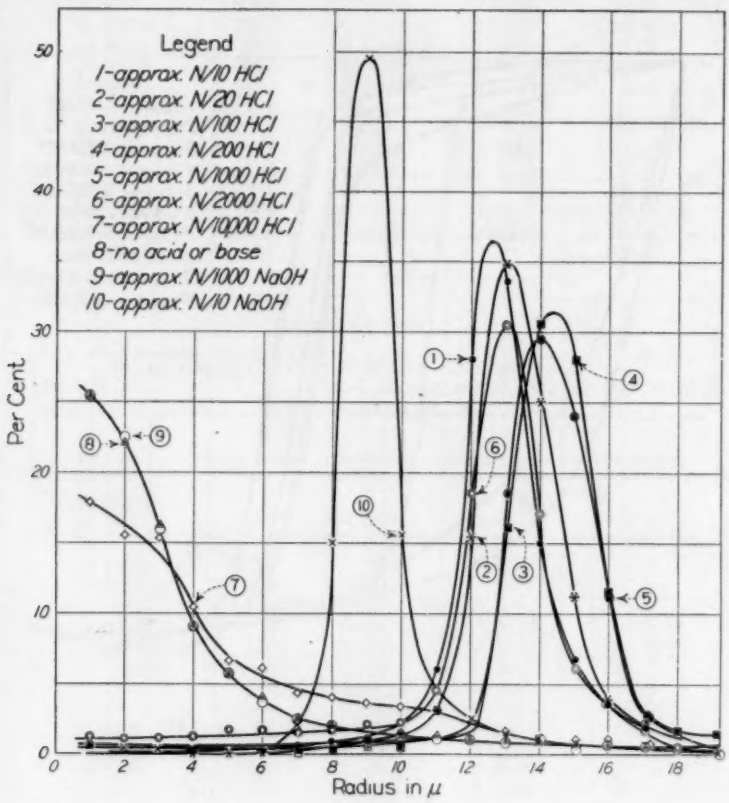

FIG. 2.

micron. Thus 1 micron indicates the entire interval from 0 to 1 micron in radius; 2 microns, the interval from 1 to 2 microns, etc. Curves 7, 8, and 9, which correspond to similarly numbered curves in Fig. 1, have peaks at a radius of 1 micron indicating that the greater part of the clay in these suspensions is made up of particles whose radii fall between 0 and 1 micron. Hydrochloric acid of concentrations $N/100$, $N/200$, and $N/1000$

[6] See A. V. Bleininger, "The Properties of Clays," Colloid Symposium Monograph, Vol. II, p. 86.

cause the greatest shifts, the maxima of all these three curves rising in the region of 14 microns; while concentrations of $N/10$, $N/20$, and $N/2000$ produce maxima at 13 microns. $N/10{,}000$ hydrochloric acid does not shift the peak, but reduces it from 25.5% to about 18%, and $N/1000$ sodium hydroxide has no effect. Figure 1 shows Curve 10 to drop very rapidly between 8 and 10 microns and as a consequence Fig. 2 shows it as a tall, narrow curve with a maximum at 9 microns.

	Determination I		Determination II		Determination III	
Radius in Microns	Cumulative (%)	Size Distribution	Cumulative (%)	Size Distribution	Cumulative (%)	Size Distribution
0	100.0	0.0	100.0	0.0	100.0	0.0
1	100.0	0.0	100.0	0.0	99.4	0.6
2	100.0	0.0	100.0	0.0	98.8	0.6
3	100.0	0.0	100.0	0.0	98.5	0.3
4	99.9	0.1	99.9	0.1	98.2	0.3
5	99.7	0.2	99.7	0.2	97.8	0.4
6	99.6	0.1	99.4	0.3	97.2	0.6
7	99.0	0.6	99.0	0.4	96.9	0.3
8	98.2	0.8	98.2	0.8	96.4	0.5
9	97.0	1.2	97.3	0.9	95.9	0.5
10	95.0	2.0	96.0	1.3	95.3	0.6
11	89.0	6.0	93.0	3.0	94.1	1.2
12	61.0	28.0	77.7	15.3	92.0	2.1
13	27.5	33.5	43.0	34.7	76.0	16.0
14	12.6	14.9	18.0	25.0	45.5	30.5
15	6.0	6.6	7.0	11.0	17.5	28.0
16	2.7	3.3	3.3	3.7	6.1	11.4
17	1.0	1.7	1.2	2.1	3.5	2.6
18			0.5	0.7	2.1	1.4
19					1.0	1.1

	Determination IV		Determination V		Determination VI	
Radius in Microns	Cumulative (%)	Size Distribution	Cumulative (%)	Size Distribution	Cumulative (%)	Size Distribution
0	100.0	0.0	100.0	0.0	100.0	0.0
1	99.4	0.6	99.0	1.0	98.8	1.2
2	98.8	0.6	98.3	0.7	97.7	1.1
3	98.5	0.3	97.5	0.8	96.8	0.9
4	98.2	0.3	96.8	0.7	95.7	1.1
5	97.8	0.4	96.1	0.7	94.0	1.7
6	97.2	0.6	95.4	0.7	92.4	1.6
7	96.9	0.3	94.7	0.7	91.0	1.4
8	96.4	0.5	94.0	0.7	89.5	1.5
9	95.9	0.5	93.0	1.0	87.6	1.9
10	95.2	0.7	92.2	0.8	85.4	2.2
11	94.1	1.1	91.2	1.0	81.0	4.4
12	92.0	2.1	89.5	1.7	62.5	18.5
13	76.0	16.0	71.0	18.5	32.0	30.5
14	45.5	30.5	41.5	29.5	15.0	17.0
15	17.5	28.0	17.5	24.0	9.0	6.0
16	6.0	11.5	6.4	11.1	5.5	3.5
17	3.5	2.5	4.0	2.4	4.0	1.5
18	2.0	1.5	2.6	1.4	3.8	0.2
19	0.9	1.1	1.9	0.7	3.8	0.0
20					3.5	0.3
21					3.5	0.0

Radius in Microns	Determination VII		Determination VIII	
	Cumulative (%)	Size Distribution	Cumulative (%)	Size Distribution
0	100.0	0.0	100.0	0.0
1	82.3	17.7	74.6	25.4
2	66.4	15.9	52.5	82.1
3	51.8	15.6	36.3	16.2
4	41.5	10.3	27.3	9.0
5	34.9	6.6	21.7	5.6
6	28.8	6.1	17.8	3.9
7	24.5	4.3	15.4	2.4
8	20.5	4.0	13.6	1.8
9	16.8	3.7	12.1	1.5
10	13.4	3.4	10.8	1.3
11	10.4	3.0	9.8	1.0
12	8.1	2.3	9.0	0.8
13	6.6	1.5	8.2	0.8
14	5.7	0.9	7.5	0.7
15	4.9	0.8	7.0	0.5
16	4.3	0.6	6.3	0.7
17	3.9	0.4	5.8	0.5
18	3.5	0.4	5.4	0.4
19	3.1	0.4	5.0	0.4
20	2.9	0.2	4.6	0.4
21	2.8	0.1	4.4	0.2
22			4.2	0.2

Radius in Microns	Determination IX		Determination X	
	Cumulative (%)	Size Distribution	Cumulative (%)	Size Distribution
0	100.0	0.0	100.0	0.0
1	74.5	25.5	99.4	0.6
2	52.0	22.5	99.0	0.4
3	36.0	16.0	98.5	0.5
4	27.0	9.0	98.0	0.5
5	21.3	5.7	97.9	0.1
6	17.7	3.6	97.5	0.4
7	15.3	2.4	95.5	2.0
8	13.5	1.8	80.5	15.0
9	12.0	1.5	31.0	49.5
10	10.7	1.3	15.3	15.7
11	9.6	1.1	10.8	4.5
12	8.6	1.0	8.4	2.4
13	8.0	0.6	7.0	1.4
14	7.0	1.0	6.2	0.8
15	6.8	0.2	5.5	0.7
16	6.1	0.7	4.8	0.7
17	5.7	0.4	4.2	0.6
18	5.2	0.5	3.8	0.4
19	5.0	0.2	3.6	0.2
20	4.7	0.3	3.4	0.2
21	4.5	0.2		
22	4.5	0.0		

Checking Experimental Results

To check the experimental work, duplicates were run on most of the determinations. For the purpose of illustrating how closely duplicates have been found to check the originals, examples are given for Determina-

tions II, III, VI, and VII. These are shown graphically in Fig. 3. The curves are the same as those of Fig. 1, while the duplicates are indicated by the points which lie near or on the curves. Curve 8 and its duplicate show the results of two determinations run more than a month apart, at different temperatures and with different heights of fall.

Another method of checking, followed by Van Nieuwenburg and Schoutens,[7] was to draw off at the time of the last reading portions of the suspension for evaporation. From the weight of the clay recovered in this way the percentage which had settled out was calculated. In the tables for Determinations VI and VII will be found the results of two such checks. In the case of Determination VI, the calculation from the sedimentation data gave 97.0%, while the evaporation method gave 95.3%, a difference of 1.7%. Determination VII gave 46.9%, while the evaporation gave 47.7%, with a difference of 0.8%. In another determination not reported above, the results were 82.4% by calculation and 82.9% by evaporation.

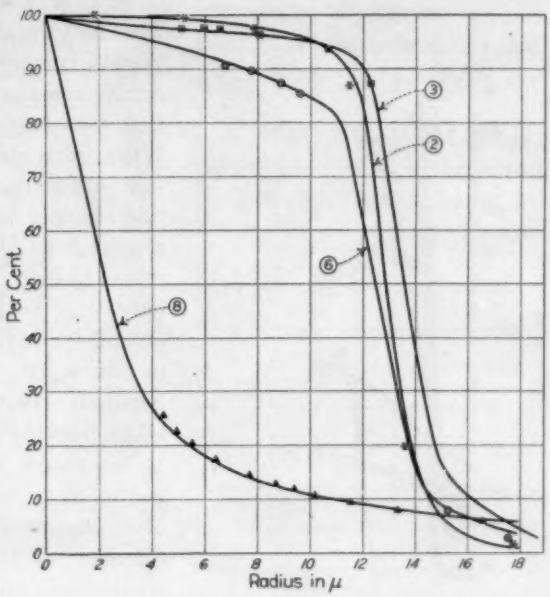

FIG. 3.

It is believed that the chief source of error lies in the correction for deposit of clay upon the plummet during sedimentation. That this is not at great variance with the facts is indicated by the checks mentioned and it is further borne out by the general smoothness of the sedimentation curves (Fig. 1) drawn through the experimentally determined points on toward the calculated point of 100% sedimentation.

Beginning of the Sedimentation Curve

From the colloidal chemist's points of view the beginning of the sedimentation curve is not of great importance because in this region the

[7] C. J. Van Nieuwenburg and Wa. Schoutens, *Jour. Amer. Ceram. Soc.*, **11**, 696 (1928).

particles are the greatest in size and hence possess the least surface and consequently the lowest power of adsorption. But experimentally, this is of interest for what it may tell of the sedimentation process in general. In Fig. 4, the ordinates are the weights upon the balance pan and the abscissae minutes of time. Curve 8 (Determination VIII) is the case of no acid or base and, as noted before, shows few large particles. Suspensions in which there is a predominance of large particles almost invariably show a lag in the density change at first. This may be due to two things: convection currents in the suspension or an actual absence of particles of the size that should drop out at this place. When great masses drop out of suspension suddenly, convection currents are undoubtedly set up. The fact that the plummet is an object with dimensions (even though its cross-sectional area is only $^1/_{50}$ that of the sedimentation cylinder) and hangs relatively stationary in the midst of the suspension would naturally create a current directed upward buoying it up. This effect must be operative longer than just at the beginning of sedimentation but it must also become rapidly negligible if the diameter of the plummet be small in comparison with the sedimentation vessel.

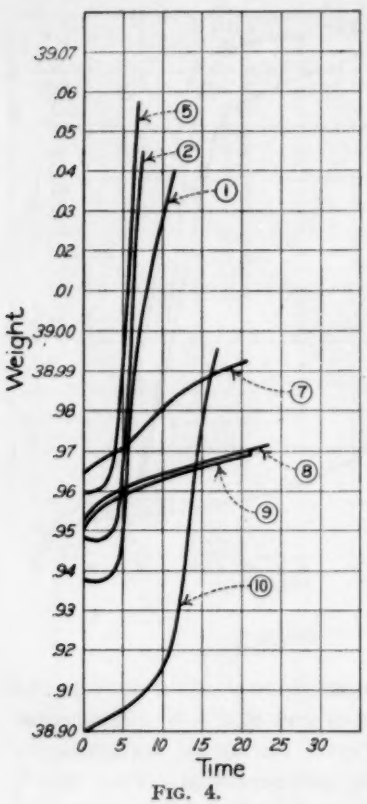

FIG. 4.

Summary and Conclusion

A Becker "chainomatic" balance, fitted with a plummet suitable for measuring densities with a fairly high degree of accuracy, was used for determining the rate of change in density of clay suspensions during sedimentation. As a result of the investigation of several suspensions in solutions of different hydrogen-ion concentration, it was found that small quantities of hydrochloric acid were effective flocculating agents, the maximum effect being produced by $N/100$, $N/200$, and $N/1000$ hydrochloric acid, while corresponding concentrations of sodium hydroxide were without effect. $N/10$ sodium hydroxide did produce flocculation, but the effect was less than that produced by $N/2000$ hydrochloric acid.

Stoke's law was assumed to hold under the conditions of the experi-

ments and the increased rate of sedimentation was interpreted as an increase in particle size. As slight a change in concentration of hydrochloric acid as from $N/10{,}000$ to $N/2000$ caused a shift in distribution from 17% with a radius of 0 to 1 micron, to 30% with a radius of 12 to 13 microns, corresponding to an enormous decrease in surface. Just how much of a decrease it is difficult to say without further knowledge of the nature of the flocculated particles.

This helps to explain why changes in the p_H of clay slips in the ceramic industry produce such noticeable changes in plasticity, viscosity, etc. It indicates, moreover, that a separation by elutriation is a most uncertain process without p_H control.

At present there seems to be no data available as to the exact change in p_H of the intestinal contents during the progress of dysentery and cholera, but these experiments show that such information must be obtained before the function of clay in the treatment of these diseases can be satisfactorily explained.

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CERAMIC CONGRESS

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February 22-28, inclusive

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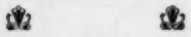

¶ The delegates will be housed in hotels by industrial groups:

Hotel Cleveland

Heavy Clay Products
Refractories
Grinding Wheel

Hotel Statler

Ceramic Art
Terra Cotta
White Wares

Hotel Hollenden

Enamels
Glass
Materials and Equipment

¶ One and one-half fare on certificate plan granted by all railroad associations.

The American Ceramic Society
2525 North High Street
Columbus, Ohio

CERAMIC ABSTRACTS

Compiled by the

AMERICAN CERAMIC SOCIETY

Ross C. PURDY, Editor

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Abrasives

Preparing fine abrasive material by new method. JOSEPH H. BRINTON. *Abrasive Ind.*, 11 [11], 48–50 (1930).—In southeastern Pa. a corundum mine was discovered some years ago in which rare specimens of margaerite clinochlore, or jefferisite were found. B. was convinced that jefferisite carried unknown abrasive properties. After considerable work on the mineral he found that by pulverizing it and concentrating it by slow evaporation an emulsion was obtained which would pass through filter paper. When this emulsion was placed in a small quantity of water containing soap, little clouds of crystals rose to the surface. An oxide of aluminum in colloid condition had been formed which possessed enough energy to attach itself in the form of microscopic crystals to a glass container and could not be removed. These minute crystals were extremely hard and sharp. B. impregnated some polishing wheels with this emulsion

which he called brintonite and found it would give a high luster to plate glass or the hardest metal. The usual scratch lines were almost entirely erased and a semipolish finish was produced. E.P.R.

Standards approved. ANON. *Abrasive Ind.*, **11** [10], 21 (1930).—Revised edition of the American standard for the use, care, and protection of abrasive wheels has just been approved by the Standards Council of the American Standards Association. The original edition of the code, approved in 1926, was recognized as the authoritative publication on the subject and was widely adopted. Progress in the grinding wheel industry during the past four years has, however, made the revised edition necessary. In 1926, the maximum speed for the vast majority of grinding wheels was 6000 to 6500 peripheral ft. per min. The present code provides for maximum speeds varying from 4500 to 16,000 ft. per min., these higher speeds having been made possible by the use of synthetic resin and rubber-bond wheels. The new code also provides for the use of steel castings for hoods for high-speed wheels, the suitability of such material for this purpose having been determined by actual destruction tests. E.P.R.

Stress abrasive progress. ANON. *Abrasive Ind.*, **11** [11], 38 (1930).—The automotive industry has been responsible for more progress in the art of production than any other influence of the past quarter-century, according to John A. Warner, general manager of the Society of Automotive Engineers which held its 9th national production meeting in Detroit in October. E.P.R.

Production and precision necessary in drill grinding. ANON. *Abrasive Ind.*, **11** [11], 32 (1930).—The extreme limits of accuracy to which drills must be held in their manufacture makes the grinding operation one of utmost precision and refinement. The first operation consists of rough grinding the fluted end of the drill 0.002 in. to 0.003 in. oversize using an outboard V-support as an aid to correct the eccentricity between the taper shank and the fluted portion of the drill. In the second operation a concentric drill grinding fixture is used, with the fluted barrel inserted in a bushing which swivels vertically to load and horizontally to allow rough grinding of the taper shank. Finish grinding of the tapered shank, the third operation, is accomplished by using a set-up similar to that of the second operation. Then the fluted barrel is finished with the desired back taper, using a set-up as in the first operation. The net production for grinding taper-shank drills from $^1/_4$ in. to $^3/_4$ in. diameter approximates 110 finished drills per hr., grinding both the fluted barrel and taper shank. Limits for roundness are held within 0.0002 in., for size within 0.0005 in., and for concentricity within 0.0015 in. A new method for centerless grinding straight shank drills recently has been developed by Cincinnati Grinders, Inc. A grinder is arranged with a special feeding arrangement which is an improvement over applications formerly used. E.P.R.

Heavy precision grinding necessary in radial drill production. ANON. *Abrasive Ind.*, **11** [11], 30–31 (1930).—Grinding methods followed at the Cincinnati-Bickford plant are the result of long experience as the company began to adopt grinding for finishing various cylindrical parts at a time when many machine-tool builders persisted in following the methods of turning and filing. This article illustrates and describes a number of interesting grinding operations performed in making Bickford radial drills. E.P.R.

Sand cores ground with modern abrasive machinery. ANON. *Abrasive Ind.*, **11** [11], 26 (1930).—The core used in a mold is subject to stringent conditions: (1) it must be high in refractory, (2) possess enough strength to support its own weight, and (3) be accurate in size and shape. Cores usually are made of high-silica sand bonded. It is molded and baked. A grinding wheel operating at approximately 4000 surface feet per minute provides a quick accurate means of finishing the cores. Since the

baked cores are comparatively soft and coarse grained, an 18 to 24 grit, silicon carbide medium-hard wheel should prove satisfactory. The vertical spindle machine is another well-designed machine for grinding cores. E.P.R.

Heavy-duty lathe parts finished accurately by precision grinding. ANON. *Abrasive Ind.*, **11** [11], 17–20 (1930).—The first practical engine lathe was invented by Henry Maudsley (1771–1831) about 1800, although the principle of the lead screw was in use to some extent before Maudsley's day. The modern engine lathe described is a product of the Monarch Machine Tool Co. This tool possesses a built-in accuracy of the highest order. The initial abrasive operation performed in manufacturing cast-iron parts consists of grinding them all over to remove surface imperfections which affords a smooth surface for lacquer. E.P.R.

Cooling solution. ANON. *Abrasive Ind.*, **11** [11], 23 (1930).—A solution of soda water or a prepared grinding lubricant should be used in cylindrical-grinding operations whenever possible. The rule also applies to surface grinding, knife grinding, etc. The larger machines are equipped with cooling systems, the solution being supplied in a constant stream at the point of grinding contact. A solution composed of sal soda and water gives excellent results in general cylindrical grinding. Plain water is not practicable as it rusts the machine and the work in process. Three well-known makers of grinding machines recommended the following solutions: 1 lb. of soda to 2 gal. of water, 1 lb. to 4 gal. of water, and 1 lb. to 8 gal. Any amount between the two extremes would be satisfactory. In general it should be stated that a thick solution should not be used when grinding up to shoulders as it prevents the operator seeing the wheel edge as it approaches the shoulder. E.P.R.

Space between wheels aids handling. ANON. *Abrasive Ind.*, **11** [11], 42 (1930).—The Production Equipment Co. has completed factory and field tests on a new, heavy-duty, extended-spindle grinding machine especially adapted to grinding awkward, heavy, or clumsy parts or materials by reason of the space between the grinding wheels and the space between the wheels and the motor housing and frame of the machine. Illustrated. E.P.R.

Wheel-speed chart. ANON. *Abrasive Ind.*, **11** [11], 39 (1930).—A useful, sliding chart for checking, grinding, and polishing wheel speed is being distributed by the Abrasive Co. The range is for wheels from 4 to 36 in. in diameter and speeds 5000 to 9000 ft. per minute. E.P.R.

Use of backrests. ANON. *Abrasive Ind.*, **11** [11], 23 (1930).—Backrests should be used on cylindrical grinding machines in grinding long, comparatively slender pieces. A good rule is to use one backrest to each foot of work on approximately 1 in. in diameter. The object of using backrests is to overcome chattering by reducing vibration. Backrests are of two general types, plain and universal. Backrest shoes are wood, bronze, hard steel, etc. E.P.R.

Air tool fills variety of finishing jobs. ANON. *Abrasive Ind.*, **11** [11], 43 (1930).—The Rotor Air Tool Co., recently has added an air-operated tool. The tool is adapted to a variety of uses in abrasive operations such as grinding, polishing, buffing, or brushing. E.P.R.

Resistance of steels to abrasion by sand. SAMUEL J. ROSENBERG. Bur. Stand., *Jour. Research*, **5** [3], 553–74 (1930).—A study has been made of the adaptability of three types of apparatus, *viz.*, the ball-mill, the sand-blast, and the Brinell machine, to the testing of the resistance of metals to abrasion. A detailed description of all apparatus used is given. The ball-mill was generally unsatisfactory; the sand-blast gave consistent results but did not differentiate between the materials tested, apparently because of the fact that the abrading conditions were not sufficiently severe; the Brinell machine proved to be generally satisfactory. R.A.H.

Grinding wheel trues polishing wheels. ANON. *Abrasive Ind.*, **11** [11], 42 (1930).—A recent development in wheel-maintenance equipment is the machine developed by the Excelsior Tool & Machine Co. A feature is the method of surfacing the polishing wheels in which a grinding wheel is used in contact with the wheel to be formed or dressed and rotates in the opposite direction. The frame of the machine is constructed of steel and mounts a motor for driving the polishing wheel and the dressing wheel. Illustrated. E.P.R.

Polishing problems discussed. ANON. *Abrasive Ind.*, **11** [11], 48 (1930).—Polishing of metals by mechanical means was discussed at the A.S.M.E. meeting in Chicago. A paper on fundamentals of machine polishing was presented by Robert T. Kent, director of engineering, Divine Bros. Co. E.P.R.

Polishing stainless steel. F. W. STURDEVANT. *Abrasive Ind.*, **11** [11], 50 (1930).—In polishing stainless steel articles the process of obtaining a mirror finish is not easily or quickly accomplished, as compared with obtaining the same finish on the ordinary ferrous or nonferrous metals. Much depends on the original surface of the metal. A smooth surface is desirable, as it permits the use of finer abrasives in removing all pits and imperfections. The amount of pressure to be applied can only be determined by experiment on a given stock, and should be variable with the different grades of grits and cuts taken on the work in process. After all wheel marks are removed, the blade is highly colored by hand on a coloring wheel. The use of these machines has reduced the cost of stainless cutlery until the use of this popular metal for domestic purposes is practically universal. E.P.R.

How machine tool parts are polished. ANON. *Abrasive Ind.*, **11** [11], 44–48 (1930).—This article illustrates and describes a number of interesting polishing operations performed at the plant of the R. K. LeBlond Machine Tool Co. on high-grade machine tools. The abrasive operations followed daily at this plant are the result of many years of practical experimentation. E.P.R.

Roll-grinding machine has modern design. ANON. *Abrasive Ind.*, **11** [11], 41–42 (1930).—The Landis Tool Co. has developed a heavy-duty roll grinding machine adapted to grinding rolls such as sheet mill, bar mill, lithographing, paper mill, and others in common use. The body may be ground straight, concaved, or crowned while the roll necks also may be trued up on the same machines. E.P.R.

Completes heavy internal grinder. ANON. *Abrasive Ind.*, **11** [11], 28–29 (1930).—Designed for heavy stock removal on large work with accuracy and finish, an internal grinding machine by Heald Machine Co. is the largest chucking, internal grinder built. E.P.R.

Bench grinder is air driven. ANON. *Abrasive Ind.*, **11** [11], 43 (1930).—A bench grinder adapted to be bolted to a portable air compressor or to a bench, and introduced by Ingersoll-Rand Co. is known as type 9. The driving unit is a three-cylinder motor with cylinders spaced about the center line of the spindle; it is designed for a free speed of 3000 r.p.m. E.P.R.

V-type belting is adapted to grinding-machine drives. ANON. *Abrasive Ind.*, **11** [11], 21–23 (1930).—Two forms of pulleys were used, the round and the V-grooved. In abrasive machine drives, where short belts must often be used, belt tension always must be somewhat excessive when flat belts are employed to insure adequate drives. An interesting application of a multiple V-belt drive to a heavy-duty crank grinding machine made by the Landis Tool Co. is shown. V-type belts applied to a heavy-duty floor grinder, a product of the Hisey-Wolf Machine Co. are shown, and an interesting application of the multiple V-belt drive to a polishing lathe is given. An important factor pertaining to V-belts is that the wear is never excessive and when a belt breaks through from long service it is easily replaced. Illustrated. E.P.R.

PATENTS

Polishing wheel. DANIEL FREDERICK MCGOVERN. U. S. 17,853, Nov. 4, 1930 (reissue). A polishing wheel, comprising a disk having on its working face groups of segmental flanges, each flange group being circularly spaced from the next adjacent flange groups, and the spaces constituting aisles extending radially from adjacent the center of the disk to the tips of the outermost flanges of the groups, and the tips of the outermost flanges of such groups starting at substantially the periphery of the disk and overlapping the outer ends of the aisles, the included flanges of each group all starting at spaced points in substantially the same plane and all the flanges of each group, including the outermost flange thereof, terminating in substantially the same plane.

Grinding machine. JAMES N. HEALD AND WALDO J. GUILD. U. S. 1,779,094, Oct. 21, 1930. In a grinding machine, means for causing relative traverse between the grinder and work while the grinder is operating on the work, means for extending the traverse to include the wheel-dressing point in the path of reciprocation so that the wheel may be dressed, and a control adapted to cause the speed of reciprocation while the grinder is operating on the work prior to the dressing operation to be different from the speed of reciprocation while the grinder is being dressed and to cause the speed of reciprocation subsequent to the inclusion of the dressing point in the path of reciprocation to be at a third rate of speed.

Grinding. SOL EINSTEIN. U. S. 1,779,467, Oct. 28, 1930. The process of producing a tubular work piece of uniform wall thickness consisting in floating the work piece between spaced abrasive wheels, respectively, engaging the interior and exterior faces thereof, and operating one of the wheels at a rapid rate to remove, by grinding, the excess of stock over a predetermined work thickness while rotating the other wheel at a slow rate to control the presentation of the work to the grinding wheel.

Centerless grinding machine. JAMES A. PHELPS. U. S. 1,779,618, Oct. 28, 1930. In a centerless grinding machine of the class described, the combination of a grinding wheel, a stationary regulating wheel, and means for positioning work intermediate the grinding and regulating wheels, the last-named means being adjustable to accommodate work of varying sizes.

Polishing-wheel heading machine. ROBERT G. PILKINGTON. U. S. 1,779,638, Oct. 28, 1930. In a polishing-wheel heading machine, the combination of a revolubly-mounted gluing wheel, means to supply the periphery thereof with glue, a packing wheel revolubly mounted opposite to the gluing wheel, means to supply abrasive to the packing wheel, a frame between the wheels and movable in opposite directions theretoward, means for revolubly and removably mounting a polishing wheel on the frame and means for moving the frame whereby the polishing wheel may occupy an intermediate position out of contact with the glue wheel or the packing wheel or may be moved into engagement with either of the wheels.

Automatic grinding machine. CHARLES H. NORTON. U. S. 1,779,779, Oct. 28, 1930. A grinding machine comprising a base, a grinding wheel rotatably mounted thereon, a pair of aligned, rotatable, axially movable, work-supporting spindles arranged to grip and rotate a work piece during grinding, means to move the wheel toward and from the work, and a single operating device to move both of the spindles simultaneously through the same distance to grip the work, which acts in timed relation with the wheel movement.

Feeler for sizing. SOL EINSTEIN. U. S. 1,779,807, Oct. 28, 1930. A work-sizing device for application to a grinding-machine table, including a bracket portion for engagement with the table, means for clampingly securing the bracket in position on the table, a dust-proof housing carried by the bracket and projecting to underlie a work

piece supported by the table, an oscillatable electrical contact mechanism contained within the housing and having a lateral extension exterior to the housing, a contact member carried by the extension and projecting for engagement with the underside of a work piece, and means for shifting the portion of the device underlying the work in a substantially vertical plane for proper engagement of work pieces of different diameters when carried by the table.

Grinding machine. HENRY H. YERK AND WILLIAM J. BAUMBERGER. U. S. 1,780,288, Nov. 4, 1930. A grinding machine for grinding external cylindrical surfaces comprising in combination, a bed, a carriage slidable on the bed, an annular headstock rotatably mounted on the carriage and arranged so that portions of the work to be ground may extend into the annular space thereof, a rotatable grinding-wheel spindle carried by the headstock, a power shaft on the carriage having its axis in longitudinal alignment with the axis of the headstock, means for rotating the headstock from the power shaft, and means for rotating the grinding-wheel spindle on its own axis from the power shaft during the rotation of the headstock, whereby the grinding-wheel spindle may be caused to rotate on its own axis and simultaneously in an orbital path about the surface to be ground.

Knife-grinding mechanism for use with slicing machines. EDWIN COULSON. U. S. 1,780,868, Nov. 4, 1930. A grinding mechanism for slicing machines of the rotary disk-knife and reciprocating-carriage type comprising a support, a pair of grinding wheels rotatably and slidably mounted relatively to the support, means for moving the wheels into and out of contact with the knife edge, a rotatable driving shaft, means driven from the shaft for effecting a reciprocation of the carriage, a clutch member slidably but nonrotatably mounted on the driving shaft, an actuating means adapted to effect the engagement and disengagement of the clutch member, means connecting the actuating means to the means for moving the grinding wheels into and out of their acting position, the connection between the actuating means and the clutch member and between the actuating means and the grinding wheel-control means being such that the operation of moving the member for disengaging the clutch and thereby disconnecting the carriage reciprocation mechanism from the driving shaft simultaneously causes the member connecting the actuating means and the grinding wheel-control means to cause the grinding wheels to move into their acting position.

Grinding reamers, etc. G. A. DE VLIEG. Brit. 334,290, Oct. 22, 1930. A machine for grinding rotary cutters, *e.g.*, reamers having unequally-spaced cutting elements, is provided with means whereby the work may be indexed automatically through unequal amounts.

Grinding screw threads, etc. F. W. BURSTALL. Brit. 334,558, Oct. 29, 1930. In the precision grinding of the threads of screws, screw-plug gages or taps, the bottoms of the threads are finished by a grinding wheel of convex profile, and the tops of the threads by a wheel of corresponding concave profile, the wheels being rigidly mounted on the same spindle in correct spaced relationship and being shaped *in situ* by the same diamond tool.

Swing-frame grinding machines. H. WADE. Brit. 334,620, Oct. 29, 1930. A swing-frame grinding machine consists of a tubular frame supporting an electric motor at one end and a grinding wheel at the other end. The wheel is supported in a guard consisting of side plates secured to the frame and an operating handle is carried by the guard.

Grinding or abrading. G. L. MURPHY. Brit. 334,729, Oct. 29, 1930. A grinding-wheel spindle of a sharpening attachment to a leather-splitting machine of the band-knife type is mounted in anti-friction and dust-proof bearings. Carrier rods, which may be adjusted axially and are held from rotating, have enlarged portions carrying

rings with internal conical surfaces which together with rings on a reduced portion of the spindle form bearing surfaces for rollers loosely held by retaining rings. The grinding wheel is mounted on an enlarged portion of the spindle between clamping plates and held by a flange, a wooden, etc., packing disk, and a screwed nut.

Grinding and milling cams, etc. CHURCHILL MACHINE TOOL CO., LTD., AND L. MAWER. Brit. 334,787, Oct. 29, 1930. A machine for grinding or milling cams and other irregularly shaped articles, comprises a swinging head mounted by trunnions on a bed, and carrying a spindle upon which is a master cam held up to a fixed roller by a weight so as to move the work to and from the grinding wheel or milling tool. The work is carried by a chuck upon a spindle, or between two centers. The frame has a lug to which is pivoted one end of a link, the other end thereof being pivoted to the machine bed; the link and the head thus form a parallel linkage system whereby movement of the head does not affect the angular speed of the work.

Art and Archaeology

Brown earthenware glazings. A. STAŠEK. *Repts. Czechoslo. Ceram. Soc.*, p. 13 (1928).—The argillaceous earths with a low melting point are used in Czechoslovakia, ordinarily in a washed state, for producing earthenware glazing, and have the following composition:

$$\left.\begin{array}{l}FeO\ 0.2373\text{–}0.2885\\ CaO\ 0.3342\text{–}0.5030\\ MgO\ 0.0654\text{–}0.2967\\ K_2O\ 0.0631\text{–}0.2174\end{array}\right\}\ Al_2O_3\ 0.4659\text{–}0.6341\ \left\{\begin{array}{l}SiO_2\ 3.8198\text{–}5.0572\\ TiO_2\ 0.0149\text{–}0.0395\end{array}\right.$$

As best material for glazing manufacture S. recommends the following composition:

$$\left.\begin{array}{l}FeO\ 0.26\\ CaO\ 0.45\\ MgO\ 0.16\\ K_2O\ 0.12\end{array}\right\}\ Al_2O_3\ 0.57\ \left\{\begin{array}{l}SiO_2\ 4.43\\ TiO_2\ 0.02\end{array}\right.$$

which can be produced from 67.1 parts by weight feldspar, 166.55 kaolinite, 169.44 quartz, 45.0 limestone, 13.48 magnesite, 20.76 ferric oxide, and 1.60 rutile. R.B.

Use of lead glaze in practice. DUEFFE. *Ind. Silicati*, **8** [8], 14–15 (1930).—Notes and practical suggestions for applying lead glazes are given. Directions for regulating the absorption capacity of the ware to be glazed, the consistency of the glaze batch for fired and unfired ware, and methods of applying glazes are discussed. M.V.K.

Selenium red. ANON. *L'Industrie Chimique*, June, 1930; for abstract see *Ceram. Abs.*, **9** [4], 252 (1930). (*S.S.*)

Ceramic class in the school for applied art in Nuremberg. WILHELM NIDA-RUEMELIN. *Keramos*, **9** [19], 39 (1930).—This is a short review of the ideas and results of the ceramic class of the school. Due to changed conditions in the building industry the sculptor will no longer find so much work as in former times, but must now work with cheaper materials, chiefly clay, and get his effect by glazes or clever shaping. The class teaches all kinds of modeling and glazing and the use of different materials. I.R.

Cambridge glass. CARL GREENLEAF BEEDE. *Christian Sci. Mon.*, **22** [293], 8 (1930).—The Cambridge Co., Mass., turned out finer goods in far greater quantity than the glass more commonly known as Sandwich glass. Cut glass was made from the beginning. Some of the cut ruby is of striking beauty. Engraving as a method of ornament is far less familiar than either etching or cutting and was done earlier on

thick material which allowed animals, objects, and ornaments to be deeply shaped. Later, thin glass necessitated shallow and airy designs. Nothing in pressed glass is more attractive than the glistening surfaces and graceful scrolling of the patterns called "lacy Sandwich." Illustrated. E.J.V.

Acid etching glassware. ANON. *Popular Sci. Monthly*, **117** [6], 51 (1930).—An illustrated description of the processes used in making modernistic patterns in pressed glassware by means of acid etching is presented. E.J.V.

Plantagenet enamel at Le Mans. G. H. WHITE. *Notes & Queries*, **159**, 112–14 (1930).—The plate of enameled copper in the museum at Le Mans, portraying a Count with a blue shield charged with golden lions, is discussed and is said to represent the Plantagenet Geoffrey V of Anjou. H.H.S.

Battersea enamels. FRANK DAVIS. *Illus. London News*, **177**, 304 (1930).—The enamel factory at York House, Battersea, was in active operation only from 1750 to 1756, when the owner, Stephen Janssen, went bankrupt. Illustrated. H.H.S.

Enamel miniatures. FRANK DAVIS. *Illus. London News*, **177**, 266 (1930).—The work of Jean Petitot, Charles Boit, and Henry Bone, is described. Illustrated. H.H.S.

Ceramic art. V. CAROTTI. *Corriere ceram.*, **11** [9], 375–79 (1930).—The aesthetic appeal of a work of a ceramic art should be based primarily on the form and shape of the object while any superimposed decoration as painting or sculpture can only be auxiliary. Since the modern mechanization of manufacture, the man at the potter's wheel can no longer have the creative interest that the ancient artisans had in fashioning their imperishable works of art. M.V.K.

Chinese dragon in art. FRANK DAVIS. *Illus. London News*, **177**, 346 (1930).—The dragon is a leading motif in all forms of Chinese art. It is now appearing on Staffordshire pottery. Illustrated. H.H.S.

Armorial dinner service with hunting scenes. P. D. M. *Notes & Queries*, **159**, 117 (1930).—Reference is made to an unusual type of Oriental dinner service with armorial design. In this, the coat-of-arms occurs on the border and the chief decoration is a meet of hounds (as seen by Oriental imagination). H.H.S.

Josiah Spode and his porcelain. CARL GREENLEAF BEEDE. *Christian Sci. Mon.*, **22** [281], 10 (1930).—It may seem that so many English names that we associate with fine earthenware and china are those of firms which began business between 1745 and 1770. That quarter-century saw the first manufacture of such wares as Bow, Bristol, Caughly, Derby, Lowestoft, Spode, Wedgwood, and Worcester as well as others that are less known. Among the very few firms that have continued from 1770 to the present is that founded by Josiah Spode. Apprentice to Whieldon in 1749, he had his own plant in 1770 producing high-class tableware. About 1795, Josiah Spode, 2nd, produced porcelain more successfully than before by mixing bone ash with clays slightly differently. He ground the clays and the bone ash together in water. Previously the raw ingredients were mixed and fired before grinding with the bone ash. This was more laborious and the material did not stand up so well in the making. Between 1770 and 1863 the tastes and fashions of the time are reflected in the steady output from the plant which Spode established. Artists of high talent were constantly employed by them, both in originating designs and in adapting those which were esteemed as the product of other countries. Among their well-known types are those which suggest Meissen and Sèvres, as well as Chinese and Japanese treatments. Illustrated. E.J.V.

Old Blue Staffordshire. ELLOUISE BAKER LARSEN. *Christian Sci. Mon.*, **22** [277], 7 (1930).—Staffordshire was the home of the English potters Here, within

a small radius lived and worked 10 noted potters, among them Josiah Wedgwood and the equally famous Josiah Spode, and it was by some one of these noted 10 that the idea was conceived of sending artists to America to paint or sketch things of national interest, later to be stamped in their pottery. These early scenes of America are gaining in historical significance. E.J.V.

300 years in North Staffordshire. H. W. MAXWELL. *The Sphere*, **121**, 283–90 (1930).—A great impetus was given to the potteries by the introduction of tea from the East in Stuart times. About 1690, Astbury introduced clay from the West Country to make the body white. Ralph Daniel speeded up production by the use of plaster molds in about 1750. The careers of Wedgwood and his contemporaries are described. Illustrated. H.H.S.

Christabel Goodwin, artist-craftsman. ANON. *Christian Sci. Mon.*, **22** [283], 8 (1930).—Christabel Goodwin has made the Lunsford clay famous through the medium of her Highwoods pottery. Her studio is near Littlecommon, East Sussex, and her clay is "dug on the spot," being ordinary brick clay. After starting by designing bird baths in terra cotta, G. studied at the Camberwell School of Art, and has since begun to make her Highwoods pottery into a modernly equipped studio. The decoration of each piece of earthenware pottery is individual. The rich shades of blue and green, which are a feature of the Highwoods pottery, are procured by cobalt and copper oxides on clay which has a large percentage of iron. Illustrated. E.J.V.

Floors, walls, and stoves of tile. HELEN JOHNSON KEYES. *Christian Sci. Mon.*, **22** [287], 11 (1930).—Early in the 16th Century, potters from Italy and Spain established in Antwerp and became the leaders in the manufacture of tin-glaze pottery. The great workshop, from 1520 to 1541, was that of Guido da Savina, a Durantine. To this period belong the earliest surviving Netherlands tile. These are in the Vyne, Tudor mansion of red brick, in Hampshire, England, built by Baron William Sandys. In his former home are nearly 400 of these floor tile of different shapes and sizes, undoubtedly imported from Antwerp, the largest being $7^1/_4$ in. sq. A favorite form is produced by 4 hexagonal tiles laid against a square which results in an octagon. The subject matter consists of portraits, human figures, animals, birds, flowers, fruit, and foliage, besides abstract designs. They are characterized by vivid color, by the absence of manganese purple usually present in majolica, and by the use of canary yellow, a brilliant hue associated with Antwerp. The earliest examples of tile pictures discovered in the Netherlands were excavated in Antwerp, and are now in the collection of Frans Claes in the Vleeschhuis Museum in that city. A pavement from the Chateau d'Oiron, near Thouars has a curious history. This castle was the residence from 1524 to 1568 of Helene de Hangest-Genlis who built a pottery on the estate. Here were made inlaid tile. Lines were engraved out of the soft paste and filled in with colored clay which was eventually polished down to a smooth surface. Later, relief ornament was added, representing masks, shields, lizards, frogs, and shells, which in their turn seemed to have been suggested by the designs of the contemporary experimenter in enamels, Bernard Palissy. This ware is known as faience of Oiron. The pavement of this castle was laid with square tile, each of which contains a letter, monogram, or shield. Dark yellow brown, black, blue, pink, green, and violet appear on cream-colored clay. In Germany, Switzerland, and Russia, perhaps because it was not placed under the patronage of any great art lovers and princely families, tile manufacture adopted a simpler form and is chiefly associated with stoves. The tile were sometimes 27 by 25 in. in size and were usually enameled in dark green, sometimes with yellow or brown ornament added. Some of them merely presented foliage and cupids, in relief, but others depicted Bible stories and allegorical and historical themes. Illustrated. E.J.V.

Fired porcelain enamel finishing. P. C. BARDIN. *Ind. Finishing*, **8** [6], 52 (1930).—

Operations and processes employed by outstanding industrial establishments are discussed. Metal cleaning and drying, application, drying and firing of prime coats and color coats, use of conveyers, firing furnaces, and stenciling apparatus are discussed. (*C.A.*)

Italy's majolica tile. HELEN JOHNSON KEYES. *Christian Sci. Mon.*, **22** [281], 11 (1930).—The tiled floors and walls of Antwerp and Delft have an Italian ancestry, which, in its turn, is Spanish. Italian potteries made majolica that ranks with contemporary painting in other media. The fundamental characteristic of majolica pottery is its tin glaze. Red, buff, or gray clay were all used. It never had the full transparency of porcelain glazes, nor did it approach them in hardness or texture. The technique of the tin glaze was imported from Spain, who learned it from the Saracens, to other parts of Europe chiefly by Majorcan shippers who traded with the great potteries in Valencia. By the year 1500 many Italian cities were competitors in majolica. The technical methods were the same but the decorations differed greatly. As the art of majolica painting waned, the output of various potteries became less individual. Faenza always held the first rank. The intensity of its blue-black and saffron paint, its emerald-green and manganese-purple which sank deeply and richly into the glaze was beyond comparison. Its outlines, too, were strangely vigorous and its subject matter was never copied from works in other media. The greatest artist from the Faenza works, Francesco Nicoluso, established himself in Seville. Urbino was noted for its delicate arabesques and traceries. Moreover, the final glazing of painted majolica with a glassy substance known as marzacotta, which greatly enhanced its beauty, was initiated there. Diruta was distinguished by its chamois-colored luster and its copies of the Hispano-Moresque ware. The ruby colored "reflets" of Gubbio are still renowned, although their secret died with their originator, Giorgio Andreoli, in the 16th Century. Castel Durante, next to Faenza, was the most prolific center of the industry and was renowned for its camaieu style, *i.e.*, monochrome painting. Some of the finest examples of majolica tile are to be found in various museums of Europe. E.J.V.

Faience from old Nuremberg. MAX SCHNEIDER. *Keramos*, **9** [19], 26 (1930).—In the 15th, 16th, and 17th Centuries there was a large trade between Nuremberg and Italy, importing Italian faiences, and soon the faience industry developed in Nuremberg. This essay tells about plates made by the old artists of that time. The designs are often Italian, and the shape of the plates is not very original, being similar to the old metal plates of former times. Illustrated. I.R.

Home painters of Nuremberg. WALTER FRIES. *Keramos*, **9** [19], 17 (1930).—At the end of the 16th Century and also in the 17th, the faience industry of Nuremberg was highly developed. The bodies were made in plants but the painting was done by painters in their own homes, therefore the name, "home painters." The essay gives information about those artists living in Nuremberg at that time who are known by those pieces which have been preserved until today. Some of them are known only by name, some only by their initials, and with the help of some pictures, F. explains the different technique and the different subjects of these many painters. Their influence comes chiefly from Italy and Holland. I.R.

Collection of Bavarian Industrial Institution, Nuremberg. GEORG RITTER. *Keramos*, **9** [19], 30 (1930).—The museum contains a collection of old and new pottery as well as odd pieces of other materials. The museum is also used for instructing ceramic artists in the art school of Nuremberg. Illustrated. I.R.

Stockholm Exhibition, 1930. GEOFFREY HOLME. *Studio* [London], No. 450, pp. 164–81 (1930).—The exhibition is said to demonstrate the new discipline, "living shipshape," characteristic of the Swedish people. The numerous illustrations include

a ceramic fountain made by the Rörstrand pottery, a tea set by the Lidköping pottery, and Orrefors glassware. **Ibid.** P. MORTON SHAND. *Arch. Rev.*, **68**, 45–100 (1930).—The August number of this *Review* is devoted to Sweden. A foreword is contributed by Baron Ramel, the Swedish Foreign Minister. There are numerous articles and a portfolio of 11 plates. H.H.S.

Shapes and decorations of ceramic ware in Soviet Russia. EDUARD BERDEL. *Keramos*, **9** [20], 745 (1930).—U.S.S.R. developed a central plant for the manufacture of ceramic colors to help the development of the porcelain and the earthenware plants in Russia. The artistic side is not as well developed because the newer generation has not found its own style. They are partially following the tradition of the old Imperial plant in Petersburg, now Leningrad. These old shapes are painted in a modernistic way. I.R.

Modern Russian pottery decoration. ANON. *Pottery Gas.*, **55** [641], 1773 (1930).—Following age-long customs, Russia is illustrating her revolutionary progress by designs on her pottery, begun in a small way in the Lomonossovsky factory. The designs now used in quantity follow the Kuznetzky fashion of the '90's. In the current year the Dulyeffsky factory has produced cups with peasant designs in place of the Chinese, *e.g.*, soldiers playing musical instruments and country scenes with tractors. From the Dmitrovsky factory come designs of aviation progress. Illustrated. E.J.V.

Mexican Exposition. RENÉ D'HARNANCOURT. *Design*, **32** [6], 134–36 (1930).—The Mexican Exposition of the American Federation of Arts, which during the winter and summer of 1930–1931 will visit New York, Boston, Pittsburgh, Cleveland, Washington, Milwaukee, Louisville, and San Antonio, illustrates the growth of Mexican culture from the invasion of the Spaniards to the present. Similarities appear between Mexican work and that of Crete, Egypt, and the Orient. Pottery has always been the most important Mexican craft. All types are found, from the primitive ware of Guanajuato baked in an open fire, to the Talavera of Puebla, the best commercial pottery of Mexico. Illustrated. E.B.H.

Mexico's decorative arts. FRANCES FLYNN PAINE. *Design*, **32** [6], 129–31 (1930).—What started as a cultural movement to organize and exhibit Mexican arts in America is becoming a practical enterprise and is affording an outlet for the diversified talents of the artists and craftsmen. We must guard against allowing American commercialism to destroy this. The Mexican is at his best creating a certain thing in a certain mood and is not suited for mass production. Hand molded and unglazed primitive pottery distinguished for simplicity and perfection is made in districts where clay is cream, white, pink, soft brown, and black. Native craftsmen rarely produce for decorative use only. Motifs of water, trees, and beasts mingle. Decorative pottery fruits made by hand to be strung up around a room are bright and interesting. Illustrated. E.B.H.

Mexican crafts. EVA BROOKS DONLY. *Design*, **32** [6], 140–44 (1930).—By way of utilizing what nature has provided for him, the native potter uses whatever clay is handy and makes what he has use for, such as cooking vessels with round bases to set in hot charcoal, water jars easily carried on the head with handles placed for easy dipping, etc. Majolica is made in many parts but Puebla is the heart of the industry, first produced under the Spanish padres. Talavero tile in blue and orange covers domes, altars, etc. Many secrets have been lost, *e.g.*, the dark blue enamel (often in relief). In the little village of San Antone, unique pottery from the native red brick clay is fashioned in distinctive forms. Vessels for ordinary use have little or no decoration, possibly a thumb nail border, but choice jars have inlays of broken crockery pressed into the moist clay often jewel-like in effect. The lizard motif is typically San Antone.

The baking is done by piling the pottery on a hillside, covering it with dried grasses, and allowing it to heat in a dense slow smudge. Illustrated. E.B.H.

Some exponents of Chimu ceramics. RAFAEL LARCO. *Art & Arch.*, **30** [4], 121–27 (1930).—The Chimu people occupying the present Trujillo, Peru, of a civilization centuries before the Incas, were perfect ceramists. Huacos or cinerary burial urns reveal domestic and warlike scenes from the lives of the people, stylized totems or gods and portraits of rare color and line. All are of the highest quality of pottery. Illustrated. E.B.H.

Proto-Corinthian pottery. HUMFRY PAYNE. *Discovery*, **11**, 285 (1930).—The British School at Athens has been excavating the site of the Heraeum on a headland north of Corinth. Most of the objects found were fragments of pottery dating from 750 to 200 B.C. Their connection with Egypt has been demonstrated. H.H.S.

Pottery from ancient Corinthian graves. T. L. SHEAR. *Illus. London News*, **177**, 244–47 (1930).—The American School of Classical Studies at Athens has continued its discoveries at Corinth of 500 B.C. to Nero's day. Illustrations of exceptionally interesting pottery are given. H.H.S.

Tenayuca pyramid. EDUARDO NOGUERA. *Discovery*, **11**, 293–95 (1930).—The excavation of this pyramid in northern Mexico during the last 5 years has thrown valuable light on the Aztecs. Many ceramic fragments of artistic value were discovered. Illustrated. H.H.S.

BOOK

Etruria Past and Present. M. A. JOHNSTONE. XV + 246 pp. Methuen & Co., London, 1930. Price 7s 6d. Reviewed in *Times Lit. Supp.*, **29**, 629 (1930).—A popular account of Ancient Etruria, not of Staffordshire, is given. H.H.S.

PATENTS

Design for dish, etc. WILLIAM P. GRAHAM. U. S. 82,422, Nov. 4, 1930.

Design for bottle. MINOT K. HOLMES. U. S. 82,326, Oct. 21, 1930.

Design for perfume bottle. LEON A. DANCO. U. S. 82,317, Oct. 21, 1930.

Design for jar. EDWIN WENDELL FUERST. U. S. 82,372, Oct. 28, 1930; FRITZ KAYAN. U. S. 82,376, Oct. 28, 1930.

Design for plate, etc. FRANK G. HOLMES. U. S. 82,375, Oct. 28, 1930; URASABURO TOMITA. U. S. 82,459 to 82,461, Nov. 4, 1930; BERNARD N. KANE. U. S. 82,471, Nov. 4, 1930; PAUL ZENKER. U. S. 82,532, Nov. 11, 1930.

Coloring glass. GLASHÜTTENWERKE VORMALS J. SCHREIBER & NEFFEN. Fr. 683,124, Oct. 11, 1929. Red colors are obtained on glass by baking Cu salts on reducing glass, *i.e.*, on glass containing or colored with sulphides. (*C.A.*)

Opalescing agent for glass and enamelware. IGNAZ KREIDL. Ger. 501,694, Dec. 3, 1927. The agent is made by mixing metals or metalloids which form white oxides and do not form colored compounds with the glass or enamel when heated to glowing with C or C-yielding materials, and heating. In the example, kaolin is mixed with caustic alkali and heated, filtered, and dried. The product is mixed with fine C and heated to 700°, forming an effective opalescing agent. MgO is also mentioned. (*C.A.*)

Cement, Lime, and Plaster

X-ray study of constitution of Portland cement. ANON. Bur. Stand., *Tech. News Bull.*, No. 161 (Sept., 1930).—The X-ray diffraction method has been applied to a study of the constitution of Portland cement clinker. It has been found that (1) $2CaOSiO_2$

and CaO combine to form $3CaO \cdot SiO_2$ and not a solid solution of $2CaOSiO_2 + CaO$; (2) $8CaO \cdot Al_2O_3 \cdot 2SiO_2$ does not exist in Portland cement systems; (3) solid solutions are not formed between the aluminates and silicates of cement systems; and (4) free CaO is not present generally in amounts as great as 2.5%. R.A.H.

Constitution of cements. N. P. COSTA. *Anal. Soc. Cient.* (Argentina), **109**, 73–96 (1930); for abstract see *Ceram. Abs.*, **9** [10], 822 (1930). (*B.C.A.*)

Studies on old mortars. KARL BIEHL. *Tonind.-Ztg.*, **54** [51], 839–41; [53], 877–78 (1930); *Pit & Quarry*, **20** [13], 70 (1930).—Continuing a series of reports previously published (*Tonind.-Ztg.*, p. 139, 1927; p. 346, 1928; and p. 449, 1929 (see *Ceram. Abs.*, **8** [8], 563 (1929))), B. reports on different kinds of old German and Persian mortars investigated. Chemical and microscopical researches on German mortars showed that the mixing proportions, even in the oldest mortars from Glouchau, are very fat and that definite methods were observed for their preparation. Trass was found only in the mortars of Kolberg which are similar to the old Roman mortars. Persian mortars came from excavations of the palace of Chosroes in Ktesiphon and are thought to have been made in the 4th Century. The description of these mortars and their chemical analysis is given. These mortars are a pure gypsum mortar without additions of sand and pure lime mortar with a great content of MgO. It is mixed very fat and has an addition of brick powder. It seems that the Persians learned the preparation of lime mortar with brick powder from the Romans as their first edifices were built with gypsum mortar. M.V.K.

Methods for calculating raw pastes in production of Portland cement. I. A. ALEKSANDROFF. *Bldg. Materials*, No. 1, 8 pp. (1930).—Tables and diagrams illustrate the article. M.V.K.

Decreasing quantity of water in slip in wet preparation of Portland cement. P. P. BUDNIKOFF, V. G. KOUKOLEW, AND V. M. LEZHOEW. *Bldg. Materials*, No. 4, 7 pp. (1930).—The authors describe investigations on the question of decreasing the quantity of water in the slip in the wet preparation of Portland cement. The addition of alkalis and alkaline salts to the slip with 48, 42.5, and 40% water gave good results. A 0.01 normal Na_2SiO_3 solution lowered the water content of the slip from 48 to 42%; Na_2CO_3 and NaOH solutions with molasses decreased the content from 52 to 40% water in the slip. The action of electrolytes can be increased by heating the water used. M.V.K.

Slag cement. P. P. BUDNIKOFF. *Bldg. Materials*, No. 2, 6 pp. (1930).—The preparation of hydraulic cements from slags is based on the fact that amorphous silicic acid contained by slags forms insoluble hydrates of silicates and aluminates when mixed with lime and water. The greater the lime content of slag, the better is the cement. Slags poor in lime must have a high content of alumina to produce good slag cements. A high content of silica makes the slag inert for the reaction. Calcium sulphate always contained in slag changes into gypsum on hardening and is not injurious to the cement. A small content of manganese, lower than 3%, is not injurious. The great quantities of slag, its cheapness, and the high qualities of slag cement make its use extended. Such cements have a great advantage over Portland cement as they are less affected by salts. Slag concrete is also less affected by salts as this concrete contains little uncombined lime. The resistance to pressure of a Portland slag cement after 28 days is from 600 to 650 kg./sq. cm. and its resistance to breaking is about 38 kg./sq. cm. M.V.K.

White "Polar Cement" (white Portland cement). ANON. *Stavivo*, p. 671 (1929).—Polar cement has been manufactured since 1929 in the cement works of Olomouc, Czechoslovakia. According to the research and tests made in the State Silicate Institute of Brno, this cement has the following properties: (1) begins to set in 1 hr.; ends

in 8 hrs.; (2) fineness of grain 2.2% on 4900-mesh sieve; (3) tensile strength of mortar composed of 1 part cement and 3 parts standard sand under water (*a*) within 3 days: tensile strength 17.0 kg. per sq. cm., compressive strength 300 kg./sq. cm.; (*b*) within 7 days: tensile strength 25.0 kg./sq. cm., compressive strength 497 kg./sq. cm.; (*c*) within 28 days: tensile strength 32.5 kg./sq. cm.; (*d*) alternate setting, 28 days: tensile strength 43.3 kg./sq. cm., compressive strength 685 kg./sq. cm. R.B.

Chemical behavior of siliceous material, trass, and diatomaceous earth in lime and cement mortar. MAX STILLER. *Tonind.-Ztg.*, **54** [38], 642–43 (1930); *Rock Prod.*, **33** [20], 89 (1930).—The hardening of Portland cement follows a different course from the hardening of a paste of trass and cement. A chemical reaction takes place between cement and trass which depends on the reacting capacity of the silicic acid in the trass. A combination with the alkalis seems to occur, however, as no alumina combination can be detected. The observations of Tannhäuser, Koch, and Hasak confirm that alkalis originate as a by-product of the reaction. With continued action, however, the alkalis are liberated as hydroxides or carbonates which react strongly alkaline and thus produce a false result in the mass-analytical determination of lime. In order to clear up this question the mass-analytical determination should be controlled by the weight-analytical determination of lime. As trass acts only after long damp storage of concrete, the time of 18 days for tests seems too short and should be extended to cover at least 12 to 15 months. M.V.K.

Trass of Karadag. C. SHCHOUKIN. *Bldg. Materials*, No. 2, 6 pp. (1930).—The deposits of trass in U.S.S.R. are found only in Crimea. It is a volcanic tufa containing the so-called "active silicic acid" which gives trass its hydraulic properties. The results of chemical analyses of trass are tabulated and compared to German and Italian trass. They show that the green Russian trass containing 71% silicic acid is especially appropriate for use in cement. Tests made with such cements show that after hardening three years, the solidity of the trass cements is much greater than that of Portland cement and it continues to increase. The most valuable property of trass is that it prevents the injurious action of sea water on concrete. The salts of sea water form $3CaO \cdot Al_2O_3 + 3CaSO_4 + 3H_2O$ and $Mg(OH)_2$ with the hydrate and aluminate of lime of hardened cement causing the disintegration of concrete. Trass prevents this formation because of the action of its "active silicic acid" which absorbs the surplus of lime and forms crystalline silicates of calcium insoluble in water. The composition of Russian trass Portland cement and its qualities are tabulated. M.V.K.

Injurious action of pure water on cement conduits. ANON. *Cemento armato*, **26**, 10–11 (1930); *Tonind.-Ztg.*, **54** [77], 1250 (1930).—Too little attention is paid to the fact that pure water free from lime and carbonic acid may greatly affect the ingredients of cement. The solubility of CaO alone amounts to 1.3 g. in a liter of such water. Of the compounds formed by the setting and hardening of Portland cement, hydrate of lime and tetra aluminate are dissolved especially. The disintegration of the latter stops only when 1.08 g. CaO are dissolved in the water. If the water is continually renewed and is under a certain pressure at the same time, the other compounds are considerably affected also; the solidity is diminished and finally a mechanical removal of supporting particles takes place. This phenomenon was studied thoroughly in a concrete conduit for drinking water. Some analytical results are tabulated. Fused cement is disintegrated in the same manner. The preparation of concrete with a structure as dense as possible is a sufficient protection against the action of water. The same injurious action is caused by pure water of different mountain springs with a high content of uncombined CO_2 but without lime, as the lime of cement is carried away as bicarbonate. Only when the formation of neutral carbonate is possible because

of the small content of uncombined CO, does pure water have little effect, because the lime combined with carbonic acid clogs the pores of the walls. M.V.K.

Shrinkage and expansion of concrete while hardening. P. FILOSSOFOV AND A. M. STCHEPETOV. *Bldg. Materials*, No. 2, 8 pp. (1930).—The authors review tests made to determine the shrinkage and expansion of concrete while hardening and describe their own tests which show that (1) the properties of the cement, sand, and aggregates used are of great importance in the shrinkage of concrete; quick-setting cements and cements of high qualities have a greater shrinkage. Sand with fine granules and porous aggregates also increase shrinkage. (2) The fatter the concrete, the greater is the shrinkage. (3) A damp environment weakens the phenomenon of change of volume of concrete during hardening. M.V.K.

Slate as raw material and fuel in cement industry. J. RAKOVSKII. *Bldg. Materials*, No. 4, 5 pp. (1930).—P. describes investigations made to determine whether Russian slates (composition given) may be used as a raw material and fuel for the preparation of clinker. Data on the clinker obtained are given. It is noted that the solidity of this clinker is somewhat lower than the solidity required by standards for clinker. M.V.K.

Reconstruction of revolving kiln for firing gypsum. WALTER KIRNICH. *Feuerungstechnik*, **18** [19–20], 189–91 (1930).—K. describes the reconstruction of a revolving kiln into a gas-firing kiln and the installation of a revolving grate generator. The kiln had been used for calcining gypsum and before the reconstruction, the gypsum produced was always soiled and darkened. The sulphur of the gypsum would combine with carbon and the gypsum was not usable. After the reconstruction of the kiln, the gypsum obtained was white and odorless; its setting time was 23 to 26 minutes. A great economy in fuel was obtained. M.V.K.

Pit furnace according to Andreas' design. JAROSLAV ŠIMÁNĚ. *Stavivo*, p. 668 (1929).—In the year 1926 Andreas designed a new cement furnace. The air is driven in by several round guiding ports arranged on the circumference of the furnace. The air inlet is precisely regulated. The raw material is not pressed with the fuel to brick shape, but simply introduced into the furnace in a suitable manner after having been mixed with a certain quantity of water depending on the kind of cement to be produced. Andreas' furnace is an important progress in the manufacture of Portland cement, and the clinker manufactured therein is in all respects of the same value as clinker from rotary furnaces. Two cement works in Czechoslovakia are provided with this furnace system. R.B.

German standard specifications for Portland cement, iron Portland cement, and blast-furnace cement. ANON. *Tonind.-Ztg.*, **54** [81], 1292–95 (1930).—The new German standards for Portland cement, iron Portland cement, and blast-furnace cement are published. The high-quality Portland, iron Portland, and blast-furnace cements are distinguished from Portland, iron Portland, and blast-furnace cements mainly by their high initial solidity. Portland cement is a hydraulic setting agent which contains not less than 1.7 parts by weight of lime to 1 part by weight of soluble silicic acid + alumina + iron oxide in its mineral structure obtained by firing. Portland cement is prepared by grinding and thorough mixing of raw materials, firing to sintering, and fine grinding of the fired product (clinker). The loss on ignition of Portland cement must amount to at least 5%. The magnesia content must not exceed 5%, and sulphuric anhydride 2.5%. Not more then 3% of foreign substances can be added after firing to Portland cement. Iron Portland cement is a hydraulic setting agent containing at least 70% by weight of Portland cement and at most 30% granulated basic blast-furnace slag which consists of lime alumina silicates. Portland cement and blast-furnace slag must be finely ground together. More than 3% of foreign substances

cannot be added to iron Portland cement after firing. Blast-furnace cement is a hydraulic setting agent containing from 15 to 69% weight parts of Portland cement and granulated basic blast-furnace slag. The slag and Portland cement are finely ground and thoroughly mixed. Slag used for the preparation of blast-furnace cement must contain at least 1 weight part of the sum of lime + magnesia + $^1/_3$ alumina to 1 weight part of the sum of soluble silicic acid + $^2/_3$ alumina. The slag cannot contain more than 5% manganese oxide. More than 3% of foreign substances cannot be added to blast-furnace cement after firing. The fineness of grinding, the beginning of hardening, and the volume stability of cements are given. The resistance to pressure of cement of high quality is 250 kg./sq. cm. after 3 days water storing; 500 kg./sq. cm. after 28 days combined storing; tensile strength, 25 and 40 kg./sq. cm. The resistance to pressure of cement must be 180 after 7 days water storing; 275 after 28 days; and 350 kg./sq. cm. after 28 days of combined storing; tensile strength, after 7 days 18, and after 28 days combined storing, 30 kg./sq. cm. The methods of testing and other requirements are described. M.V.K.

New German cement standards. HAEGERMANN. *Tonind.-Ztg.*, **54** [77], 1237–41 (1930).—H. discusses the new German cement standards and compares them with the old specifications. M.V.K.

Portugal cement standards. ANON. *Tonind.-Ztg.*, **54** [83], 1319 (1930).—New standards are published for Portugal Portland cement. It must not have more than 4% loss on ignition, 1.5% insoluble residue, 4% MgO, and 2.5% SO_3. The specific gravity must be more than 3.05. The setting time must amount to more than 1 hr. and less than 8 hrs. The determination of solidity must be made on a mixture of 1 part cement and 3 parts of standard sand. The resistance to pressure must amount to 200 kg. after 7 days and 300 kg. after 28 days water storing. Tensile strength must be 17 kg. after 7 days and 21 kg. after 28 days water storing. For air storing, the values must be 150 kg. for resistance to pressure and 12 kg. tensile strength after 7 days; 240 and 60 kg. for the resistance to pressure and tensile strength, respectively. M.V.K.

Concrete institute in Russia. ANON. *Tonind.-Ztg.*, **54** [81], 1299 (1930).—A concrete research institute has been founded in Leningrad, U.S.S.R., which will undertake to determine the best concrete mixtures from given raw materials. It also has the problem of finding out the standards for the building industry. M.V.K.

Ground clay as plasticizing agent. New use for clay. M. G. SPANGLER. *Jour. Amer. Ceram. Soc.*, **13** [12], 927–28 (1930).—A series of tests have been conducted to determine the relative tensile strength of mortars containing hydrated lime and finely-ground raw clay used as plasticizing agents. These tests reveal no distinct difference between the two materials in this respect.

Influence of clay additions on mechanical properties of Portland cement. A. V. FILOSSOFOV AND F. A. SOROMITIN. *Bldg. Materials*, No. 1, 4 pp. (1930).—Investigations were made on Portland cement with additions from 0 to 30% clay. Data on the fat brick clay used and clinker with an addition of 4% gypsum are given and tests described. The results are given in tables and show that the setting is not influenced by the quantity of clay although pastes with clay set quicker than pure cement containing 4% gypsum. The mechanical solidity of cements is lowered in proportion to the clay content, but, on the other hand, the density is increased. Unfired clay cannot be used as an addition to Portland cement. M.V.K.

Setting and hardening of cements used for stopping oil wells. B. KEMMER AND B. BÀLAN. *Bldg. Materials*, No. 2, 6 pp. (1930).—Tests were made to ascertain the influence of water containing petroleum and petroleum emulsions on the setting and hardening of cement used for plugging oil wells. Additions of 5, 10, and 15% petroleum (its composition is given) were added to the water. The results of these tests are

tabulated and show that (1) small additions of petroleum (5%) do not influence the qualities and properties of cement and (2) only cements of high qualities which harden quickly can be used for plugging the wells. M.V.K.

BULLETIN

Hot cement. H. Davey. H. M. Stationary Office. 4d, net. Bldg. Research, *Bull.*, No. 7; *Engineering*, **130** [3376], 411 (1930); for abstract see *Ceram. Abs.*, 9 [8], 619 (1930). A.A.

PATENTS

Making Portland cement. Frederick W. Huber. U. S. 1,781,232, Nov. 11, 1930. In the manufacture of Portland cement from a raw material which contains calcium phosphate in substantial amounts and in which the mineralizing components are in too small amount to give a good cement by calcining with argillaceous material at usual cement-calcining temperature and pulverizing, the herein described improvement which comprises adding argillaceous material to the material, and adding an iron oxide material in such amount as to bring the total iron content up to substantially above the chemical equivalent of the phosphate radical content, then calcining the mix at the usual cement-calcining temperature and under conditions capable of converting substantially the entire amount of phosphate radical into iron phosphate while leaving a substantial amount of iron oxide to act as a mineralizing agent for the cement, and thereafter reducing the calcined material to a fine powder.

Process for obtaining hydraulic binding agents. I. G. Farbenindustrie A.-G. Ger. 496,958; *Tonind.-Ztg.*, **54** [52], 865 (1930); *Rock Prod.*, **33** [20], 89 (1930).—Sulphides of alkaline earth such as calcium sulphide, when used as addition agents were shown to develop their hydraulic binding energy through a latent hydraulic binding power. They can replace a part of Portland cement as stimulator, or it is possible to obtain considerably higher solidities by adding calcium sulphide with an equal addition of Portland cement. Calcium sulphide reacts with water according to the equation $2CaS + 2H_2O = Ca(OH)_2 + Ca(SH)_2$. In this way it increases the alkalinity and the stimulating action. According to the invention, a quantity not exceeding 10% of sulphide of alkaline earth can be added to a paste of slag with Portland cement, vitrified marl, or hydraulic lime during grinding. M.V.K.

Preparation of water-tight concrete. Richard Shubert. Ger. 502,017, Feb. 23, 1928; *Tonind.-Ztg.*, **54** [78], 1258 (1930).—A liquid coal tar is mixed with insulating materials and concrete and water is added at the place of construction. Combining coal tar with the insulating material, *e.g.*, siliceous materials, asbestos, etc., makes the coal tar more absorbable, and it sets more easily with concrete. The tar mass is absorbed by the surface of the insulating material. After this, the mass is mixed with cement, concrete, etc. M.V.K.

Enamels

Salute to vitreous enameling industries. Edward Orton, Jr. *Bull. Amer. Ceram. Soc.*, **9** [11], 314–16 (1930).—In this radio address delivered from KDKA, Westinghouse Station, October 7, 1930, O. discusses what porcelain enamel really is and methods by which it is made. The discussion is a concise exposition which is readily understandable by a layman. E.J.V.

Effect of variations in compositions on properties of vitreous enamels. Anon. Bur. Stand., *Tech. News Bull.*, No. 160, p. 78 (1930).—It is customary to express the compo-

sitions of enamels in terms of the percentages of the various constituents, no attempt being made to indicate the actual chemical constitution for lack of knowledge on that point. The Bureau considered it important to learn something more definite about the effects of variations in raw materials on the properties of enamels of given composition before attempting to correlate the compositions with quantitatively determined properties. Using analyzed raw materials, two enamels were prepared having the same calculated ultimate compositions, but different batch compositions. Cone deformation tests showed a distinct difference in fusibility between the two enamels. A detectable difference in the indices of refraction was also found. It was shown that the differences in the properties of the two enamels was due to some more stable condition than arrested reactions. R.A.H.

Thermal and chemical resistance of enamels for sheets. ANON. *Glashütte*, **58**, 816–18 (1928).—The various qualities required in enameled metallic articles, particularly kitchen utensils, are discussed, and the properties required in the enamels and the methods of estimating them are reviewed. It is recommended that K_2O, CaO, Na_2O, CaF_2, and NaF should be eliminated from the enamel, that the SiO_2 content be raised as much as possible without detriment to the fusibility, that the Al_2O_3 be reduced, and that BaO and ZnO (in very small quantities), B_2O_3 and MgO be added. It is stated that by the use of glass powder (Glasmehl) instead of feldspar, high quartz or SiO_2 contents may be obtained. (*J.I.S.I.*)

Testing fineness of enamels. VIELHABER. *Emaillewaren-Ind.*, **7** [40], 315–16 (1930).—V. points out the necessity of testing the fineness of enamels because the ground enamel always contains particles of different size which affect the quality of the enamel and produce spots on the enamel layer. It is practically impossible to obtain grains of uniform size. The grinding, however, should be done in such a way that a definite quantity of grains of a fixed grain size be present in order to insure the right proportion of different sized grains. M.V.K.

Terrar as white opacifier. WILHELM LINKE. *Emaillewaren-Ind.*, **7** [41], 321–22 (1930).—Terrar is a first-class opacifier; its properties are not inferior to those of tin oxide, but it is cheaper. It is an opacifier containing zirconium oxide which is changed by very complicated chemical processes into a form appropriate for opacification, and is not found in a pure form, but is an important ingredient of compounds. Terrar can be used for a wet or dry coating. Both kinds are free from poisonous substances as arsenic, antimony, barium, lead, and zinc. It can be used as a mill addition for every flux. The use of tin oxide and terrar together has the great advantage of producing a better enamel than when either of these substances are used separately. For instance, for a plate enamel applied wet, 3% terrar and 1% tin oxide added to the mill give a perfect result. Terrar can be used with success in batches containing lead which loses its poisonous character. See also *Ceram. Abs.*, **9** [11], 921 (1930). M.V.K.

White ground coating. K. ALTMANNSBERGER. *Sprechsaal*, **63** [40], 762–63 (1930).—The following composition of a white ground coating gives very good results: borax 33 kg., quartz 25 kg., feldspar 19 kg., soda 6.5 kg., cryolite 4 kg., potassium fluosilicate 4 kg., O. leuconine 4 kg., fluorspar 2.5 kg., soda saltpeter 2 kg. For the mill: frit, 100 kg., quartz, 15 kg., clay, 7 kg., O. leuconine, 4 kg., ground leuconine γ 4 kg. The content of fluxes in per cents (boric acid, sodium fluoride, etc.) amounts to 52% and the action of alkalis is strongly diminished. The opacifiers, *e.g.*, cryolite, leuconine, and sodium fluosilicate, amount to 12%; the frit produces a pure white. The coefficient of fusibility (proportion of fluxes to refractory constituents) is 1.03 (about 770°) for the batch. If the coefficient of fusibility is 0.8 to 1.1 for ground coating of cooking utensils, then the white ground coating is easily fusible. It is applied in the same manner as a cobalt ground coating and is fused in at the normal temperature (870 to 900°C). In-

vestigations of the adhering solidity confirmed the denseness and uniformity of the coating. The advantages of this white ground coating are an exceptional covering power and tenacity. M.V.K.

Decalcomania as applied to porcelain enameled products. G. HARRY FRANK. *Better Enameling*, **1** [6], 4–9 (1930).—Transfers for marking and decorating industrial products, household appliances, furniture, and porcelain enamel are called decalcomania. There are two classes of transfers, the oil color and the metallic oxides. The method of making and applying oil color "decals" is given. W.C.O.W.

Reprocessing defective ware. ANON. *Better Enameling*, **1** [6], 20–26 (1930).—Common defects in the application of enamel are discussed and corrective methods that may be applied to correct the defect in time to prevent its making rejection necessary when the finished work is completed are suggested. W.C.O.W.

Mechanical coating of utensils. VIELHABER. *Emaillewaren-Ind.*, **7** [41], 322–23 (1930).—If a piece of iron is cooled below 0° and put in a closed damp space the piece is soon covered with ice. If the dampness contains fine, suspended enamel and clay granules, the enamel and clay are precipitated on the iron and freeze. When the iron is heated the clay retains the enamel particles. The piece of iron can be dried and then fired. The thickness of the deposit can be regulated by cooling the iron according to its thickness; thus thick pieces are cooled less than thin. In this way it is possible to precipitate mechanically an exact, uniform thick coating on every piece of iron. M.V.K.

Preparing sheet metal for enameling. ANON. *Better Enameling*, **1** [6], 14–19 (1930).—The standard practice for cleaning, pickling, and rinsing sheet metal preparatory to enameling is given, together with the proper strength for solutions, temperatures, construction of pickling tanks, etc. W.C.O.W.

Nickel ground and fishscaling. VIELHABER. *Emaillewaren-Ind.*, **7** [43], 337–38 (1930).—There are two kinds of fish scales: (1) those which reach the metal sheet and (2) those which are only on the surface layer. A gas like hydrogen can always produce a formation of fish scales on the finished coat whether it is enameled with a cobalt or nickel ground coat because further formation of gases is always possible. The reason for the appearance of fish scales when using nickel or cobalt grounds is always traced to the firing. If the firing time is lengthened and the heat in the kiln is less intense, or admixtures of highly expansive material such as clay are added to the mill, fish scales do not appear. The enamel layer melts before the adhering layer is quite formed and the enamel particles which are not yet solidly united with the metal are forced out of the enamel layer by oxygen during firing. In a nickel ground this appears more often as the latter is more easily fusible than a cobalt ground. M.V.K.

Scale and oxide removed rapidly by electrochemical process. ANON. *Iron Age*, **126** [13], 860–61 (1930); *Chem. & Met. Eng.*, **37** [10], 634–35 (1930).—The Bullard-Dunn process is an electrochemical method of removing scale, oxides, grease, and dirt from metal surfaces by the action of hydrogen electrically generated on the surface of the metal beneath the scale or oxide. A feature of the process is the protection of the surface from pitting and embrittlement. The apparatus consists of two large tanks. One contains a sulphuric acid, hydrochloric acid, and sodium chloride mixture in solution, while the other contains soda ash, trisodium phosphate, and caustic soda mixture in solution. The acid solution is used for scaling and the alkaline for removing grease. The anodes in each tank are long slabs of metallic lead. The material to be cleaned forms the cathode. As soon as the pieces are immersed, the evolution of hydrogen starts and a thin coating of lead is deposited on the piece. The lead may be removed by placing the piece in the alkaline bath and reversing the current. E.C.C.

Testing enameled articles in regard to their application in industrial chemistry.

W. LOKSCHIN. *Keram. Rund.*, **37**, 757–60 (1929); see also *Ceram. Abs.*, **9** [11], 980 (1930). (*J.I.S.I.*)

Use of silicon carbide muffles in enameling and in ornamental ceramics. ANON. *Keram. Rund.*, **37**, 718–19 (1929).—Silicon carbide is not suitable for small muffles. Its high price is not outweighed by its durability, and it burns rapidly. It can, however, be used to advantage for large muffles with thick walls. The fuel economy may reach 20 to 50%; the durability is good, and repairs are few; there is little oxidation, and that is only superficial. (*J.I.S.I.*)

Furnaces for vitreous enameling. A. D. DAUCH. *Heat Treating & Forging*, **15**, 1346–50 (1929); see also *Ceram. Abs.*, **8** [12], 867 (1929). (*J.I.S.I.*)

Economical installation of japanning ovens. W. J. MISKELLA. *Fuels and Fur.*, **7**, 1741–44 (1929).—The factors entering into the selection of the most economical oven to suit the product and plant conditions are discussed. (*J.I.S.I.*)

Enamel muffle kiln with continuous operation. ANON. *Emaillewaren-Ind.*, **7** [43], 339–40 (1930).—A description of a tunnel kiln of the "Grossalmerode" system is given. It is an elongated tunnel kiln in which the ware goes through the muffle and firing zones in a straight line. In the preheating zone the radiating heat of the firing zone is used for preheating the ware. The thin wall plates of the muffle are made of "Sico" (silicon-carbide) which besides being very resistant to fire has an exceptional thermal conductivity. The ware is fired on suspended grates. M.V.K.

Porcelain enameled sign. ANON. *Better Enameling*, **1** [5], 18–25 (1930).—Methods employed in making paper and zinc stencils for simple and complicated porcelain enameled signs are described. W.C.O.W.

Production of enameled ironware. W. HÖNSCH. *Die Giesserei*, **16**, 1145–51 (1929).—The difficulties encountered in producing enameled ironware, constitution of and faults in castings which adversely affect the enameling process, suitable composition for iron for enameling, relative contraction of cast iron and enamel, factors affecting the contraction of cast iron, and faults in enameling for which the foundry is responsible are discussed. (*J.I.S.I.*)

Enameled table tops. ANON. *Ironmonger* [London], **9**, 8 (1930); *Emaillewaren-Ind.*, **7** [40], 317 (1930).—The English company, Western Enamelled Ironworks, Ltd., Gloucester, makes porcelain enameled table tops in white, cream, Turkish blue, sage green, and green yellow. M.V.K.

BOOK

Sheet Steel and Tin Plate. R. W. SHANNON. Chemical Catalog Co., Inc., N. Y.; Westman Publications, Ltd., Toronto. 272 pp. Price $5.00. Reviewed in *Can. Chem. Met.*, **14** [10], 52 (1930); *Mining & Met.*, **11** [287], 10–12 (1930).—This book is a well-illustrated treatise on the practical operations involved in manufacturing commercial steel products with particular reference to rolling mill practice and the application of protective coatings. The book is written for the technically-trained layman and no effort is made to deal with the metallurgy of steel. E.J.V.

PATENTS

Making enamelware. OSCAR HOMMEL. U. S. 1,779,273, Oct. 21, 1930. (1) In the manufacture of enamelware having a body of metal and a surface coating of vitreous nature the procedure herein described which consists in coating the surface of a body of a ferrous metal with a film of oxide of another metal selected from a group consisting of cobalt, nickel, and manganese, and forming the enamel coating upon the surface so prepared. (2) In the manufacture of enamelware the procedure herein described which consists in coating the surface of a body of iron or steel with carbonate of cobalt,

reducing the coating to a film of oxide upon the surface, and forming upon the film-covered surface a coating of enamel.

Atomizer for materials in powder form. FRITZ SCHORI. U. S. 1,781,603, Nov. 11, 1930. An arrangement for atomizing materials, particularly materials in powder form, comprising in combination, a portable receptacle adapted to take up a stock of the material to be atomized, a hand apparatus containing a nozzle, means to supply a medium under pressure to the nozzle of the hand apparatus whereby a suction action is generated, and gravity-supplied depending conduit means downwardly discharging and a hose connecting the lower end of the receptacle to the hand apparatus and having atmospheric air-admission means to admit air after the material has left the receptacle for conveying the material to be atomized from the receptacle to the hand apparatus by the suction action of the nozzle by which it is atomized by the same pressure medium which generates the suction.

Enamels. DEUTSCHE GASGLÜHLICHT-AUER-GES. M. B. H. Ger. 503,354, Oct. 5, 1927. Dull, rough-surfaced enamels are prepared by adding to a normal enamel composition about an equal weight of aluminous materials, *e.g.*, clay, kaolin, or cryolite, melting, and then adding a further 10% of clay and 10% of an opacifying agent, with or without 5% of Al_2O_3. (*C.A.*)

Glass

Studies of raw materials of the frit and their reaction in the batch. ANON. *Sprechsaal*, **63** [43], 812–17 (1930).—The properties of the separate raw materials, sand, soda, sulphate, limestone, and calcite are discussed and the reactions (1) of sand with carbonates of alkaline earth, (2) sand with alkaline salts, and (3) carbonates of alkaline earth with alkaline salts are described. When heated to 1250°, a mixture of sand and carbonates of alkaline earth (100:30) does not melt. Particles of calcite begin to burst under the pressure of their CO_2 content. The coloring changes from light yellow into gray; separate sand grains are no longer seen but after stirring lightly the grains fall apart again. When heating a mixture (100:30) of sand and alkaline salts (soda and sulphate) to 1250° the alkaline salts fuse easily and are enriched by silicic acid; they soon become supersaturated, and the silicic acid is precipitated again in the form of cristobalite. The alkaline melt acts as a catalyzer. In the mixture of carbonates of alkaline earth and alkaline salts (100:30) also heated to 1250° the ingredients containing lime begin to burst. The alkaline salts melt and in a short time the whole mass is fused. On cooling, this mass hardens very quickly and is of a dirty yellowish-green color. It does not have the character of glass. After this a mixture of all the components of the batch (in right proportion) is heated in a platinum foil to 1250° and studied. Calcite immediately begins to disintegrate and shortly after this, drops are formed which gradually enwrap all the particles of the batch. The first phenomena of fusing are produced by CaO and Na_2O compounds. While the drops are forming, a second escape of gases takes place, probably produced by the dissolving silicic acid (a chemical reaction), while the first escape of gases is influenced by the thermal disintegration of calcite. In this state, 12 to 15 seconds after heating in the muffle, the material to be fused represents a melt in which only sand grains are not yet dissolved. The melt is covered with numerous gas bubbles which injure its clarity. As the melt is still poor in silicic acid and not viscous, the gas bubbles escape easily, but with the increase in the silicic acid content and viscosity, the gas bubbles no longer escape. Even after heating for 12 hrs. to 1250° gas bubbles are present, although the glass substance is uniform and there are no streaks. During the study of these pro-

cesses, numerous photos were taken which show the gradual changes taking place in the batch. M.V.K.

Dimensional changes caused in glass by heating cycles. A. Q. TOOL, D. B. LLOYD, AND G. E. MERRITT. Bur. Stand., *Jour. Research*, **5** [3], 627–46 (1930); for abstract see *Ceram. Abs.*, **9** [10], 829 (1930). R.A.H.

Calculation of glass compositions from the batch and vice versa. C. E. GOULD AND W. M. HAMPTON. *Glass Ind.*, **11** [11], 249–52 (1930).—Composition by analysis rarely agrees with the composition calculated from the batch used. Assuming that the batch is accurately weighed and the mixing properly carried out, there are three factors which operate to make the glass composition different from that calculated from the batch: (1) the presence of impurities in the raw materials; (2) loss of constituents from the glass by volatilization; and (3) solution of refractories in the glass. Examples of various calculations which are made in determining glass compositions are given. E.J.V.

Glass. K. LONBERG-HOLM. *Arch. Rec.*, **68** [4], 329–58 (1930).—This is a valuable report of technical news and research on the physical properties of glass, the main divisions of which are (*a*) permeability to visible radiation, (*b*) permeability to short wavelength ultra-violet radiation, (*c*) permeability to heat, (*d*) acoustical properties, (*e*) permeability to fluids, and (*f*) mechanical properties. Tables and illustrations. E.B.H.

Effect of feldspar in glass. E. W. KOENIG. *Glass Ind.*, **11** [11], 264–66 (1930).—Feldspar is an important ingredient in all types of glassware. Alumina can best be incorporated in glass as feldspar. Feldspar has a low melting point and its composition is held so closely to established standards that the variation from shipment to shipment is negligible. The mixing of feldspar in glass batches presents no more of a problem than any other batch constituent. It is not a "cure-all." Feldspar-bearing glass is more resistant, lustrous, and a better all-around product. A bibliography of alumina in glass is included. Illustrated. E.J.V.

Borax in glass manufacture. ANON. *Pottery Gaz.*, **55** [641], 1758–61 (1930).—A report of the discussion on this subject conducted at the Glass Convention at Buxton in Sept. 1930 is given. Members taking part in the discussion and presenting varying viewpoints included Edward Meigh, E. A. Coad-Pryor, S. English, G. Simpson, John Currie, A. J. Somer, and W. E. S. Turner. See also *Ceram. Abs.*, **9** [11], 995 (1930). E.J.V.

Rare impurity in caustic potash and a consequent fault in lead glass. O. LECHER. *Sprechsaal*, **62**, 429 (1929); *Jour. Soc. Glass Tech.*, **13**, 204*A* (1929).—During the manufacture of Pb glass, with equal amounts of KOH and K_2CO_3, it was found that the product was dull. This was traced to the presence of 1.45% K_2S in the KOH. Replacement of the faulty material removed the defect. (*C.A.*)

Beryllium for glass may become cheap. HAROLD S. BOOTH AND GILBERTA G. TORREY. *Glass Ind.*, **11** [11], 268 (1930).—Through the study of electrolysis of non-aqueous solutions of beryllium salts it was found that beryllium may be electrodeposited from such solutions, making it possible to manufacture this metal in large quantities at a price that will make possible its use in many industries. Beryllium glass has already been successfully developed by Alexander Silverman, at Pittsburgh. E.J.V.

Decoloration and fusion tests. SILBERT GUSS. *Sprechsaal*, **63** [42], 792–96 (1930).—G. describes investigations on decoloration of batches with different additions of cullet, which show that the addition of the decolorant to the frit must be uniform because if the decolorant is not added to the whole frit, several color tinges are obtained in the pots with over-colored glass at the top and under-colored at the bottom. Daily control of the color tinges in the separate pots is necessary, but the quantity of

decolorant cannot be regulated from samples of the glass before it is cooled because the refraction of light of the uncooled glass is too great. Decoloration and discoloration are different whether the glass is cool or hot. If the glass is cooled rapidly only a small displacement of the state of equilibrium of the previously liquid glass batch occurs because the free movement of the particles is soon stopped by the increased viscosity or solidification. In a well-cooled glass the separate particles have a longer time to rearrange themselves and the tempering colors, gold ruby, sulphur ruby, selenium ruby, and copper ruby, attain their complete development only when cooled slowly. M.V.K.

Effect of time and temperature on solubility of bottle glass in water. CARL SCHMID. *Sprechsaal*, **63** [40], 759–62 (1930).—S. reviews and discusses tests made to ascertain the action of water on glasses of different composition and the effect of time and temperatures. The change in the solubility by increasing the temperature from 0 to 100°C and the course of the time curve at these temperatures are not known. S. describes his investigations on the question and gives the results in curves. A glass of the following composition was used: SiO_2 62%, CaO 13.3%, BaO traces, Al_2O_3 9.8%, Fe_2O_3 0.9%, Mn_3O_4 0.3%, Na_2O 9.8%, K_2O 3.6%. Practically all glasses of a similar composition were found to have a high resistance. This is due to the high content of SiO_2 and Al_2O_3 especially. The temperature (70 to 75°) had no influence during the time observed (4 to 5 hrs.); the glass withstood temperatures of 90° for 2 to 3 days without noticeable effects. The "surface resistance" was not diminished after 14 days by the action of water at temperatures up to 50°. S. concludes that liquids may be kept for a year at ordinary temperatures without affecting the glass. M.V.K.

Effect of oil on devitrified glass surfaces and the detection of this defect in glass. P. WOOG. *Bull. Soc. chim.*, **47** [4], 450–53 (1930).—Very slight devitrification of the surface of glass is rendered evident by treating the surface with an oil, especially if this contains traces of water. The particles of silica resulting from the devitrification become detached and form a suspension in the oil. (*B.C.A.*)

An artist tours a glassworks. III. ANON. *Pottery Gaz.*, **55** [641], 1764–65 (1930).—Mouth blowing, press and blow, chair work, and pressed ware production methods are described briefly and illustrated. For Part II see *Ceram. Abs.*, **9** [12], 1039 (1930). E.J.V.

Electric eye finds flaw in bottle. ANON. *Popular Sci. Monthly*, **117** [6], 33 (1930); for abstract see *Ceram. Abs.*, **9** [9], 758 (1930).—Illustrated. E.J.V.

Volumetric determination of silica in glass. N. A. TANANAEV AND A. K. BABKO. *Ukraine Chem. Jour.*, **5**, 71–85 (1930).—0.25 g. of powdered glass is treated in a platinum basin with 4 g. of potassium fluoride, 10 cc. of water, and 5 cc. of hydrochloric acid. After 15 min. 10 cc. of alcohol are added, and after 2 hrs. the precipitate of potassium fluosilicate is collected, washed with 50% alcohol, mixed with 20 cc. of 4 *N*-calcium chloride solution, and diluted to 250 cc. The solution is titrated at 100° with 0.5 *N*-sodium hydroxide solution until the supernatant solution becomes clear. The number of cc. of sodium hydroxide solution used in a blank determination is subtracted from the result obtained. The above method gives results about 0.3% higher than the theoretical. See also *Ceram. Abs.*, **9** [10], 832 (1930). (*B.C.A.*)

Radioactive method for testing the properties of glasses. O. HAHN AND H. MÜLLER. *Chem. Zentr.*, **i**, 1355 (1930); for abstract see *Ceram. Abs.*, **9** [9], 625 (1930). (*C.A.*)

Sixty years of glass testing by chemistry. F. SPÄTE. *Sprechsaal*, **60**, 1035–40 (1927).—The development of testing and the various texts on this subject published during this period are discussed. See following abstract. (*C.A.*)

Chemical testing of glasses. F. SPÄTE. *Ber. Fachausschüsse*, **3**, 1 (1926); *Jour. Soc. Glass Tech.*, **13**, 67–68*A* (1929).—Standard methods of testing the durability of

glasses are studied. It is impossible to test all glasses by a universal method. The difficulty caused by differences in the physical conditions of glasses is discussed. The best methods are given for individual cases, together with a comprehensive summary of these methods. They are (1) weathering method (Mylius); (2) extraction method (Mylius); (3) solubility of glass in the form of powder (Keppeler); (4) autoclave with water at 120° and 180°; (5) influence of 20% HCl (Weber and Laurer); (6) influence of *N*/1 NaOH (Weber and Sauer); (7) staining method (Zschimmer); (8) staining method (Heinrichs and Tepohl); and (9) Calvin method (K. Bodendorf). For plate glass, window glass, hollow glass, and lighting glass are recommended methods 1, 2, 3; for lead crystal glass, and optical glass, methods 1, 2, 3, 7, 8; for water-resistant tube glass, methods 2, 3, 4; for chemical apparatus glass, methods 2, 3, 4, 5, 6; for medicine bottles, methods 1, 2, 3, 9. A comprehensive bibliography includes references to (1) general durability; (2) decomposition of glass by water and other agents; (3) dependence of the reactions of glasses on their constitution; (4) reactions and study of glasses of known composition; (5) apparatus glass; (6) optical glass; (7) weathering methods; (8) influence of glass on chemical processes; (9) electric methods of solubility estimation; (10) influence of glass on the surface tension of water; and (11) water glass. See also *Ceram. Abs.*, **7** [6], 355; [8], 529 (1928); **8** [9], 641 (1929). (*C.A.*)

Distribution of temperature in the shaft of the Fourcault machine. R. I. SHARASHKIN AND M. G. STEPANENKO. *Sprechsaal*, **61**, 731–34 (1928); *Jour. Soc. Glass Tech.*, **13**, 109*A* (1929).—As a preliminary toward establishing a complete heat balance of the Fourcault machine, temperatures were measured both horizontally and vertically in the shaft by means of *N*-filled thermometers and thermocouples. The results of readings, taken horizontally at 9 points above the first pair of rollers, were tabulated and graphed, showing that while there was a symmetrical lowering of temperature to right and left of the middle of the glass sheet, the temperature at the midpoint was generally high, indicating a hot-air current up the center of the shaft. Vertically, above 3 definite points, the fall in temperature was gradual, except where influenced by open dampers in the shaft. The tests were carried out on 9 machines, erected according to the Belgian system, *i.e.*, above a common channel, the axis of which was at right angles to that of the tank furnace. The symmetry of the temperature curve indicates that each shaft was encircled by currents of heat of equal values. It was concluded that greater thickness of glass sheet required correspondingly more intensive heat conditions. Thermocouples were best suited for tests of this kind, which were carried out under extremely difficult conditions. See also *Ceram. Abs.*, **9** [2], 94 (1930). (*C.A.*)

Refining glass. H. KALSING. *Glas Keram. Ind.*, **20** [9], 8 (1929); see also *Ceram. Abs.*, **9** [3], 172 (1930). (*C.A.*)

Drawing glass mechanically. ANON. *L'Industria*, **44**, p. 6 (1930); *Ind. Silicati*, **8** [8], 9–11 (1930).—The mechanical method of drawing glass is replacing the old system of blowing glass because it affords a means for improving the quality, increasing the production, and reducing the number of skilled workmen who are becoming scarce. The development of the mechanization of glassdrawing with descriptions of the processes of Colburn, Libbey-Owens, and Fourcault is given. M.V.K.

Observation of temperatures of annealing chambers for hollow ware. R. D. CHANDORKAR AND K. R. RANGAIYENGAR. *Jour. Indian Ceram. Soc.*, **2**, 98–103 (1930).—Data are presented on the observed temperatures of the annealing chambers ordinarily used in glass plants. The coal consumption is also stated. A.A.

Manufacture of rolled plate. II. ERNST LUTZ. *Glass Ind.*, **11** [11], 255–61 (1930).—Precautions in regard to charging are given. The process of melting is discussed in considerable detail and the watching of pots is described. At the beginning

of the refining the molten glass is still viscous so that the stirring requires considerable force. The stiffness of the mass retains a great amount of gas. During the refining period, however, the temperature soon rises and the glass gets so liquid that the gases in solution are liberated, while the rest of the gases, which were simply held back by the great viscosity, escape. Methods and precautions to take in cooling down the mass of glass are discussed at length. The routine of the day's work on a furnace is outlined. The considerations on the melting and refining of plate glass have brought out the stringent conditions set for such a furnace. A detailed discussion of the design and construction of furnaces is presented. Illustrated. For Part I see *Ceram. Abs.*, 9 [12], 1035 (1930). E.J.V.

Historical notes on manufacture of optical glass at Murano. U. DE GHELTOF. *Ind. Silicati*, **8** [8], 13 (1930).—Salvino Armato of Florence was said to have invented spectacle lenses in 1286 but records show that lenses were being made at Venice and Murano about the same time. Although spectacle lenses continued to be made at Murano until after 1850 the industry had gradually died out in Italy, becoming a foreign monopoly. Only very recently through the efforts of Luigi Morassi of Murano, has optical glass been made in Italy which can compete with the foreign product. M.V.K.

Corrosion of tank blocks by opal glasses. C. J. UHRMANN AND S. M. SLATER. *Jour. Amer. Ceram. Soc.*, **13** [12], 931–34 (1930); for abstract see *Ceram. Abs.*, 9 [3], 166 (1930).

Contact metamorphic formations in glass kilns. M. A. BESBORODOV. *Compt. rend. l'Acad. Sciences l'Union Rep. Sov. Soc.*, **15**, 357–62 (1930); *Tonind.-Ztg.*, **54** [82], 1313 (1930).—Change through contact metamorphosis appears in the contact of natural rocks with an eruptive body. The peculiarity of the contact reaction is that the bodies react on each other in a solid state and the general texture and shape of the original bodies do not change. The results of such contact reactions in nature are observed in the transition of limestone into amphibole and the formation of andalusite, cordiesite, mica, and feldspar in argillaceous natural rocks. B. describes some cases of contact metamorphosis in glass furnaces, in which the Dinas and grog blocks of the walls reacted with the dust of the frit carried along by the gas or air currents. B. observed that under similar conditions Dinas blocks were more injured than the adjacent grog blocks. The Dinas blocks changed into a kind of "Breccia" of white stony particles and green glass, part of which flowed down from the blocks in the form of drops and small stalactites. Their analyses showed that the glass was a sodium aluminium silicate and the stony particles were pure silicic acid. The adjoining grog blocks participated in the reaction also as their alumina content promoted the fusibility of the glass by migration into the contact batch. M.V.K.

Deterioration of window glass in storage. ANON. Bur. Stand., *Tech. News Bull.*, No. 162, p. 102 (1930).—A study has been undertaken to determine, if possible, the conditions necessary to prevent the scumming or surface deterioration of window glass in storage. The samples used were furnished by six manufacturers and included both flat-drawn and cylinder glass. Accelerated tests to compare the resistance of the samples were made by immersing the glass in water and solutions of sodium carbonate, trisodium phosphate, hydrochloric acid, and iodeosin and by subjecting the glass to steam in an autoclave. Storage tests were made by placing the glass over water in a closed container and included tests with the glass sheets in contact with each other and with the sheets separated by paper. Only the autoclave tests gave results that were comparable to the results obtained by the storage tests. Dipping the glass in dilute hydrochloric acid, a practice which is generally followed, seems to reduce weathering materially. Separating the sheets with soft, porous paper which contained very

little mineral salts was also very beneficial. The bulk of the evidence at the present time indicates that any of the glass used in this investigation will not deteriorate if stored so that moisture can not condense on the surface of the glass. R.A.H.

Gas-tight sealing of metal to glass. G. ASCHERMANN. *Glas App.*, **10**, 115 (1929); *Jour. Soc. Glass Tech.*, **13**, 230*A* (1929).—A coefficient of expansion for the metal, some 5% lower than that of the glass, favors the production of a gas-tight seal on cooling. If the outer layer of the wire is of Cu, this can, by suitable treatment, be caused to dissolve in the surface layer of glass to give a very good seal. When metals of low expansion coefficients such as Mo or W ($45–52 \times 10^{-7}$) are used, it is necessary to have recourse to special low-expansion glasses, such as Pyrex, either for the whole of the apparatus or for the first member of a graded seal. Ni-chrome alloy wires up to 0.4 mm. diameter can be sealed directly into Pb glass, and will carry currents up to 2 amperes without trouble. Trouble with seals carrying large currents is sometimes due, not only to the relative expansions of glass and conductor, but also to the electric conductivity of the glass setting up electrochemical action between the two, which ultimately leads to the failure of the seal. It is possible to seal to glass Cu conductors for carrying currents of the order of 150 amperes provided they are suitably proportioned, *e.g.*, as a broad narrow ribbon or a tube with walls tapered at the point-end to a sharp edge of about 10°. Several means of executing such joints are illustrated. (*C.A.*)

September plate glass production. P. A. HUGHES. *Glass Ind.*, **11** [11], 270 (1930).—The production of polished plate glass in the U.S. for September, 1930, was 7,979,223 sq. ft., as compared with 5,523,305 sq. ft. produced in August, 1930. This makes a total of 21,828,704 sq. ft. for the third quarter of 1930, and 85,196,079 sq. ft. produced in the first nine months of 1930. E.J.V.

Russian clubhouse of glass. ANON. *Popular Sci. Monthly*, **117** [6], 63 (1930).—A workingmen's clubhouse, recently opened in Moscow, is built almost exclusively of glass, much of which is fully transparent, though parts of the wall are merely translucent and designed only to admit light. Illustrated. E.J.V.

New bottle plant for Venezuela. H. L. DIXON CO. *Glass Ind.*, **11** [11], 268 (1930).—An entirely new bottle plant is being built for the Compania Anonima Cerveceria de Caracas, of Caracas, Venezuela. The plant consists of a 12 x 16 T. continuous melting furnace, oil fired. It is provided with a 4 ft. 6 in. diameter by 80 ft. high steel stack, a Bethel feeder, and a Lynch L. A. machine. Molds for the machine include those for four types of bottles, *i.e.*, 1/6 l., 1/3 l., 1/3 l. champagne, and 2/3 l. The annealing will be done by a Dixon auto-thermal leer. An itemized list of miscellaneous equipment and materials used in the construction of the plant is given, the firm supplying each item being named. E.J.V.

BOOK

Philological Studies in Ancient Glass. MARY L. TROWBRIDGE. Univ. of Ill., *Studies in Language and Literature*, **13** [3–4], 203 pp. (1930).—Published by the Univ. of Ill. Press, Urbana. The study is designed to supplement from the side of written records, the works of archaeology. The different Greek words by which glass was designated, such as kyanos, lithos, chyte, hyalos, and krystallos, as well as the Latin vitrum, are taken up chronologically, and their etymology, orthography, derivatives, compounds, and meaning are discussed. There is presented what the Greeks and Romans themselves record of the manufacture of glass; the story they tell of its origin, of the materials, where to obtain them, and what proportions to use; of how to build the furnace, and color and handle the molten glass; of the different kinds of glasses, and where they were made. From the Roman law there is obtained a glimpse of the social standing of the workmen in glass factories, of the classification of glass with pre-

cious metals and the evidence for the importance of the trade. In Homer, glass in the form of paste or enamel was known and called kyanos. He mentions a table with feet of kyanos. Its use in decorations of armor was widespread. From the references, the idea of darkness or blackness is conveyed. Theophrastus mentions both light and dark kyanos and states that there are three kinds, Egyptian or artificial, Scythian or lapis lazuli, and Cyprian or azurite, indicating blueness. When other uses of glass than adornment of surfaces became familiar, a new term, lithos chyte, or molten stone was used by Herodotus. Introduction of transparent glass brought a new term, hyalos, from hyein, "to rain." Although hyalos usually meant glass, it was also applied to other transparent substances, such as crystal, glazes, and precious stones. Latin words for glass are discussed indicating that hyalos appears almost as soon as vitrum, the common word for glass, and continues in use rather late. It occurs chiefly in poetic and scientific works. In early Latin literature there is no mention of glass, although there is no doubt that the Romans were perfectly familiar with the material itself. The word, vitrum, "glass," first occurs in Lucretius' De Rerum Natura. Its origin is uncertain. According to Isidore "it is called glass (vitrum) because it is transparent to the sight (visui) on account of its clearness." Vitreus, "of glass," is the most common derivative of vitrum, but just as in the case of vitrum, many figurative meanings based upon the characteristics of glass came into use, especially in poetry, and there, particularly in the description of water. In the majority of cases "like glass" seems to refer to the shining, bright, sparkling, clear, or transparent appearance of glass, or rather to a combination of these characteristics. As impurities often gave ancient glass a greenish tinge, it has been suggested that vitreus when applied to water means a sparkling sea-green color. Crystallus, like the Greek kyrstallos, probably stands for glass at times. The origin and meaning of the Greek morria and the Latin murra have long been subjects of speculation. Whenever the source of supply of murrine vessels is mentioned in ancient authors, it is always an eastern one: Egypt, Partha, and Carmania. They were objects of luxury and it is likely that the ancients themselves were unfamiliar with the exact nature of the vessels. Some think murrine to be glass mosaic. Under the manufacture of glass, Pliny's account is given of the natron merchants placing blocks of natron under their kettles on the sand and after the fire was going, observing this new substance in transparent streams. This is a tradition only of the origin of glass, scientists agreeing that it is technically impossible. The raw materials mentioned are sand, natron, magnet-stone, and shells, in the older method. In his own day he says the sand was made fine as possible and then melted with three parts of soda. The available supply of fuel influenced the location of glass factories. The wood used was light and dry. Stirring after melting was recommended. Good descriptions of furnaces are lacking as well as formulas for coloring glass. There are indications of glassmakers buying up old glass and remelting it. Shaping was done by hand as blowing glass was discovered not long before the Christian era. Glass was worked upon the lathe, and carved like silver. Colored glass was used to imitate gems. Glassworkers were called vitrifactores or artifices and many signed their names. One Bounneri Kerami, "Bounneri the potter," is interesting, showing that it was possible to apply the term keramens, "potter," to a glassworker. Natural resources greatly influenced the location of manufacturing centers and as Egypt possessed both sand and nitrum the first mention of glass in Greek and Latin is in connection with that country. Alexandria was one of the greatest glass manufacturing centers of antiquity. The one ancient detailed account of glass ascribes its origin to the Phoenician coast where there was excellent sand along the Belus river and also at Sidon. The importance of Sidon is shown by the number of workmen who signed their names as Sidonians. Stories of the manufacture of glass in the far East are less trustworthy. Pliny praises glass from

India although it is doubtful if it was then made in India. In the time of Strabo, clear cheap glass was being made in Rome. Accounts are given of glass being made in Gaul and Spain but none in Greece. It was not until the beginning of the Roman empire that we know much about glass. There is some evidence that the Romans found the process of making glass so difficult and expensive that an extensive trade in old glass saved the process of fusion. An outline of the uses of glass is given. At first, chiefly ornamental objects, in the flat, molded from a paste and later from clouded glass were made. Then came the revolutionizing influence of the invention of blowing glass, making the manufacture of hollow ware, especially drinking vessels, of great importance. The perfection of transparent glass made it very valuable. Finally, the technique of making large sheets of glass was discovered. The first use of glass was probably as a glaze for necklaces and other jewelry. To the Greeks of the classical age, glass was foreign; to the Romans of the first century B.C. something new and to both, something extremely useful and ornamental. The first reference to a glass vessel occurs in Aristophanes' Acharnians where ambassadors at the Persian court drank from ekpomata, goblets of glass and gold. The term angeion, "vessel" corresponds to our test tube. Hyalos, hyalion, vitrum, a "glass" is the most common way to designate a glass vessel. Among other terms "vas" or "vasum" (utensil) was a very general one. "Vasa" was a term for jar used in preserving oil and pickels. "Amphora" was usually a long vessel, but also designated a bottle or flagon. "Phiale" "phiala," or "fiala" was used for a shallow wine cup. Powdered glass was sometimes used as medicine. Glass mirrors were invented at an early date. G.R.S.

PATENTS

Making blown-glass articles. LEONARD D. SOUBIER. U. S. 1,778,735, Oct. 21, 1930. In apparatus for forming hollow-glass articles, the combination of a receiver to which unmolded charges of glass are periodically delivered, a funnel-shaped guide positioned and arranged to direct the glass charges to the receiver, suction means for attaching the glass charges to the receiver, the guide forming a means to control the shape of each charge of glass after it has reached the receiver, means to withdraw the guide vertically away from the receiver, and means to blow the glass charge to hollow form during withdrawal of the guide, initial blowing of the glass charge being effected while the latter is in contact with the guide.

Leer feeder. PERCY Q. WILLIAMS. U. S. 1,778,742, Oct. 21, 1930. The combination of a leer conveyer, pivoted coöperating jaws forming with the conveyer an article-receiving pocket, means to place articles in the pocket at regular intervals, a pusher bar for removing articles from the pocket, rotary cams, connections between the cams, jaws, and bar, whereby rotation of the cams periodically opens the jaws and actuates the pusher bar, means to impart a rotary movement to the cams, mechanism actuated by entry of articles into the pocket to control the periods of rotation of the cams, the last-named means including a trigger projecting into the pocket in the path followed by articles entering the latter, whereby the trigger will be moved by contact with the articles, electrical devices controlled by movement of the trigger for regulating the periods of rotation of the cams, and auxiliary control means actuated by opening of the jaws to cause continued rotation of the cams and actuation of the bar while the jaws are open.

Manufacturing glassware. WILBERT S. WILLIAMS AND DAVID L. MIDDENDORF. U. S. 1,778,743, Oct. 21, 1930. The method of producing stemmed and footed glassware which comprises pressing a blank with an abnormally heavy end, and then drawing such end downwardly and outwardly by mechanical means into and against an open foot mold.

Leer. RICHARD LA FRANCE. U. S. 1,778,763, Oct. 21, 1930. A glassware-anneal-

ing leer comprising a ware-receiving tunnel having an imperforate floor, an endless ware conveyer, a heating unit arranged to heat at least a portion of the tunnel by radiation, and means to conduct products of combustion from the heating unit into direct contact with a portion of the conveyer to heat the latter prior to entry into the tunnel.

Delivering charges of molten glass. LEONARD D. SOUBIER. U. S. 1,778,775, Oct. 21, 1930. The combination of a container for molten glass having an outlet opening in the bottom thereof, means for supplying glass to the container, a tapered screw-threaded plug projecting downward into the glass over the outlet, and a tapered sleeve surrounding the plug.

Glass tank. GEORGE W. BATCHTELL. U. S. 1,780,164, Nov. 4, 1930. In a glass tank formed of blocks, a metal plate protruding over and located in proximity to the surface of the glass, and means for protecting the upper surface of the plate from the heat of the furnace.

Making glass insulator. DAVIDGE H. ROWLAND. U. S. 1,780,246, Nov. 4, 1930. The method of making an insulator of a type having a permanently-attached suspension element, comprising molding a glass body about the suspension element and passing an electric current through the element to effect heating thereof during molding, and continuing the heating until after the glass has set.

Manufacturing glass. CHARLES HEUZE. U. S. 1,780,590, Nov. 4, 1930. (1) The hereinbefore described process for the manufacture and annealing of glass sheets, comprising a forming step accomplished at high speed, an annealing step during which the sheet moves at a reduced speed, and an intermediate step during which the sheet is given an alternate fore and aft movement. (2) In an apparatus for the intermittent manufacture of glass sheets, the combination of a sheet-forming machine, means to move the same transversely of its line of feed into two forming positions, a leer provided with means for feeding the sheets therethrough at a speed less than the speed of sheet formation, a plurality of carriages, means for moving each carriage from one of the sheet-forming positions into alignment with the leer, a roller bed carried by each carriage, and means for driving the rollers of the beds at speed of sheet formations and at the speed of leer feed.

Making laminated glass. JAMES H. SHERTS AND ROBERT E. HAMILL. U. S. 1,781,084, Nov. 11, 1930. A process of treating a laminated plate made up of alternating sheets of glass and cellulose plastic having their opposing surfaces secured rigidly and solidly together, which consists in submerging the plate in a bath of pyroxylin plastic solvent in direct contact with the plate throughout, raising the temperature of the bath to a point at which the plastic is softened, and applying pressure to the bath.

Washing off felts of polisher runners in glass-polishing apparatus. JAMES HARRIS GRIFFIN. U. S. 1,781,226, Nov. 11, 1930. The combination with a plurality of successively mounted polishing heads and a plurality of traveling polishing tables movable beneath the heads, of tracks disposed parallel to the path of movement of the tables, a pair of tracks disposed adjacent to each head and in a plane above the surface of the tables, a truck on the first-named tracks, a wheeled table on the truck and movable on the second-named tracks into position between the polishing head and the first-named tables when the former is moved vertically upward clear of the table, and means on the wheeled table for cleansing the polishing heads.

Manufacture of blown-glass articles. SYDNEY HUNT. U. S. 1,781,233, Nov. 11, 1930. In a machine for the manufacture of blown-glass articles having a blowing head and a sectional neck mold, the halves of which are pivoted so that they can be opened and closed together; a construction in which the blowing head is furnished with a depending dowel pin located diametrically opposite the pivotal axis of the halves of the mold, and in which the halves of the sectional mold are provided in the neighborhood

of their joint when closed together with means for engaging corresponding means on the dowel pin for the purposes set forth.

Feeding molten glass. KARL E. PEILER. U. S. 1,781,340, Nov. 11, 1930. Apparatus for feeding molten glass comprising a container for the glass having a downwardly-opening discharge outlet, means for externally heating the outlet, a normally stationary vertical flow-regulating member having a lower end of relatively small cross-sectional area adjustably positioned in the outlet and having, above the lower end, an enlarged portion adapted to throttle the outlet and to seat in the outlet on downward movement of the throttling member to stop the flow of the glass therethrough, and means for severing mold charges from the glass below the outlet.

Drawing sheet glass. ENOCH T. FERNGREN. U. S. 1,781,452, Nov. 11, 1930. (1) In an apparatus for drawing sheet glass, a source of molten glass, a receptacle for a pool of molten glass and in open communication with the source, a pair of movable bottom members for the receptacle providing a slot of variable width therebetween, a pair of refractory partition members within the pool of molten glass, the members projecting into the slot at their lower ends so as to define three separate parallel slots in the bottom of the receptacle, one between the partitions and one between each partition and the adjacent bottom member, a cooler within the molten glass between the partition members, means for applying heat to the glass passing through the two outer slots, and means for drawing away a sheet of glass from below the slots. (2) In a sheet glass forming apparatus, a cooler comprising a hollow body portion, and a series of fluid conduits or pipes within the hollow body, the pipes terminating at different points within the cooler so that the cooling fluid may be applied selectively throughout the length of the cooler. (3) In an apparatus for drawing sheet glass from a receptacle containing molten glass, a pair of heating chambers arranged at either side of the sheet near its source, each chamber comprising a transverse series of independently adjustable vanes or plates for shutting off to any desired degree the opening between the heating chamber and the sheet.

Making articles of glassware. ROBERT J. BEATTY. U. S. 1,781,565, Nov. 11, 1930. (1) The method of producing glassware which comprises pressing a blank in a one-piece mold, blowing the pressed blank in another one-piece mold to a shape that will still allow its removal therefrom, and then blowing the shaped blank in a mold other than a one-piece mold to a shape which would preclude removal from a one-piece mold. (2) Apparatus for producing articles of glassware comprising a primary shaping table having both individual press and blow molds mounted thereon, the blow mold being of one-piece construction, and a secondary shaping table having multi-piece blow molds mounted thereon disposed adjacent the first-named shaping table and operating in timed relation with the primary shaping table.

Glass manufacture. SOC. ANON. D'ETUDES ET DE CONSTRUCTIONS D'APPAREILS MÉCANIQUES POUR LA VERRERIE. Brit. 334,056, Oct. 15, 1930. Relates to automatic glassworking machines of the kind in which molds or receivers rotate about a vertical column and receive charges of molten glass from a feeder. The mold table or support rotates continuously, but it is also reciprocated horizontally at such a speed that each mold remains stationary for a short time beneath the feeder while it is receiving a charge of glass.

Glass manufacture. A. C. FORSTER. Brit. 334,186, Oct. 22, 1930. Relates to the manufacture of glass bottles or jars of the kind in which a ledge is formed around the inside of the mouth to form a seating for a closing device, such as bottles for holding foodstuffs or milk. A ring mold used in a machine for making this ware is so formed that the glass which constitutes the seating is prevented from being deformed by the action of the air when a parison is blown to a finished bottle.

Glass manufacture. LAX & SHAW, LTD., J. E. BRANFORD, AND J. F. SHAW. Brit. 334,213, Oct. 22, 1930. Relates to a feeder of the plunger type in which a tubular member surrounds the plunger to control the weight of the charges of glass discharged by the plunger.

Laminated glass. F. B. DEHN. Brit. 334,378, Oct. 22, 1930. In making laminated glass having a nonbrittle sheet mounted between coated sheets of glass, the coating for the glass sheets consists of a mixture of gelatin and a solvent therefor, cellulose composition, and a solvent therefor, and a mutual solvent.

Glass manufacture. CORNING GLASS WORKS. Brit. 334,453, Oct. 22, 1930. Relates to a glassworking machine, of the kind described in Brit. 276,606 (see *Ceram. Abs.*, **7** [1], 25 (1928)), which embodies an endless glass-conveying apron and glassworking units that move in unison with the apron during their operative run. The machine comprises an endless glass conveyer which travels in a closed path and consists of articulated sections adapted to receive molten glass, preferably in the form of a continuous ribbon, the sections being provided with orifices through which the glass can sag. Glassworking mechanisms are mounted on the conveyer adjacent to each orifice, and molds may be carried by the conveyer or by a second belt which moves in registration with, or below, the orifices. The air for blowing the glass is supplied by reservoirs which are carried by the glassworking units and are charged during their travel with a predetermined volume of air at a predetermined pressure.

Fused silica. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 334,470, Oct. 22, 1930. A method of forming hollow vessels of fused silica consists in mechanically rotating a closed silica tube and heating a portion of the closed end, inserting the softened portion of the rotating tube in a suitable synchronously-rotating mold, and applying air pressure to the interior of the tube to distend the softened portion in the mold. The softened portion may also be offset from the body of the tube during the blowing operation.

Glass manufacture. Y. BRANCART. Brit. 334,488, Oct. 29, 1930. Relates to a casting table of the kind which is cooled by circulating water beneath the plate that forms the surface of the table and in contact with ribs which are formed thereon to increase its cooling surface. Means are provided for keeping the water in contact with the plate however it may be bulged by the heat of the glass, and for removing the steam that tends to accumulate under the bulged portions.

Glass manufacture. C. H. RANKIN AND RANKIN AUTOMATIC GLASS FEEDER CO. Brit. 334,560, Oct. 29, 1930. Relates to apparatus for feeding molten glass of the kind in which a hollow plunger is reciprocated vertically above an outlet in the floor of a forehearth, means being provided for applying suction and compression to the space within the plunger, which is carried by a holder to which a rotary or oscillatory movement is imparted independently of its axial movement. The rotary plunger holder is mounted on a bracket secured to a piston rod which is movable in a cylinder to effect the axial movement of the plunger.

Glass manufacture. UNITED GLASS BOTTLE MANUFACTURERS, LTD., AND T. C. MOORSHEAD. Brit. 334,586, Oct. 29, 1930. Relates to glass-shaping machines of the type in which a pressing plunger is used for forming a cavity in the molten glass. The pressing plunger is actuated by gravity in order to keep the pressure on the glass uniform irrespective of any variations in the amount of glass in the mold.

Fused quartz. W. GLEICHMANN. Brit. 334,720, Oct. 29, 1930. A method of preparing fused silica free from bubbles consists in feeding pieces of rock crystal which have been preheated to about 600°C, into the flame of an oxyhydrogen blow-pipe, so that they are projected by the flame against a surface where they gather to form a fused mass.

Laminated glass. L. J. KOLB. Brit. 334,768, Oct. 29, 1930. In apparatus for

making laminated safety glass, the glass assembly is placed within an open-ended rubber bag and is surrounded by strips or templets which serve to protect the edges of the assembly during the pressing operations, the bag being then clamped in an air-tight manner at its open end, exhausted of air, vapor, moisture, etc., by means of a pump, and placed on the upper surface of a supporting table adapted to be placed within a chamber for heat and pressure treatment.

Binder for laminated glass. HENRY A. GARDNER. Can. 302,911, Aug. 12, 1930. For abstract see *Ceram. Abs.*, **9** [12], 1043 (1930). (*C.A.*)

Composite glass. HUMPHREY DESMOND MURRAY AND DOUGLAS ARTHUR SPENCER. Fr. 683,510, Oct. 18, 1929. To prevent the celluloid layer in composite glass from turning yellow, a solution of an agent changing the wave length of the light is incorporated in the substratum of the elements of glass. Thus, the substratum may be composed of gelatin saturated by a salt of a cinchonic alkaloid such as the sulphate of quinine or of β-naphtholdisulphonic acid. The celluloid also contains one or more substances which prevents its decomposition or which forms uncolored compounds with the colored decomposition compounds, such as an alkali silicate and glycerol. See also *Ceram. Abs.*, **9** [5], 347 (1930). (*C.A.*)

Heavy Clay Products

Clays for making heavy ware. ANON. Bur. Stand., *Tech. News Bull.*, No. 162, p. 102 (1930).—In the heavyware industry manufacturing such products as face brick and sewer pipe, considerable trouble is often experienced from bloating and coring. The color is often affected because of improper oxidation of the iron present. It is known that carbon and sulphur are the main impurities in the clays which cause most of the trouble. The Columbus branch of the Bureau while studying the fundamental properties of twenty-seven of these clays from Ohio, determined the total sulphur and carbon present. The clays are all alluvial, glacial, and shale in origin, and are scattered over the state. The total sulphur content ranges from 0.01 to 0.84% and the total carbon ranges from 0.28 to 3.01%. The work includes firing of specimens and shows that when considering a clay of these types for commercial use it is worth while to make a determination of sulphur and carbon and to avoid clays of much higher percentages than that indicated above unless one is prepared to use much longer periods in the early firing than is the usual custom. R.A.H.

Avoiding losses in brick factories. A. REZÁČ. *Repts. Czechoslo. Ceram. Soc.*, p. 1 (1925). R.B.

Drying installations in modern steam brickworks. W. LEDER. *Tonind.-Ztg.*, **54** [77], 1242–44; [78], 1255–56 (1930).—L. discusses the efficiency of drying installations and gives data on the cost of drying per 1000 brick. M.V.K.

Possibilities of brick drying. ANON. *Tonind.-Ztg.*, **54** [80], 1276–78 (1930).—Different ways of drying brick are described: (1) plain drying is the oldest and most unreliable way, which consists in drying brick in the air and sun; (2) drying in sheds is also an uncertain method, although somewhat better than the first method; (3) artificial drying wherein drying installations are built above the kiln and the brick are dried by heat from the kiln. Drying installations most used are the drying chambers which can be divided into three groups: (1) Installations with a direct current where the evaporation of water goes on very slowly. The heat is obtained from the use of waste steam or other sources. The highest temperature, increasing the absorption of water by the dry air afterward removed by ventilators, is reached at the end of the drying process. (2) Installations with counter-currents using a great quantity of air

to avoid condensation. (3) Installations with alternating currents where the ware is predried with pure hot air and then subjected to a second severe drying with flue gases. According to another classification, the drying chambers can be distinguished by the methods of introducing the hot air; installations where the drying air is introduced in the chamber from below and removed at the crown, and vice versa, where the air enters from the ceiling and is removed at the base. There are also channel drying installations having the same specifications as the drying chambers. These installations are from 30 to 60 m. in length. The channel installations are constructed for a direct or indirect heating of ware. The movement of air is regulated by ventilators. M.V.K.

Investigations on scum and efflorescences on brick. ANON. *Tonind.-Ztg.*, **54** [78], 1252–53 (1930); for abstract see *Ceram. Abs.*, **9** [3], 185 (1930). M.V.K.

Recent improvements in methods of brickmaking. I. II. ALFRED B. SEARLE. *Jour. Roy. Soc. Arts*, **78**, 1006–20, 1024–40 (1930); for abstract see *Ceram. Abs.*, **9** [7], 530 (1930). (*C.A.*)

New York building code for hollow tile. F. E. EMERY. *Brick Clay Rec.*, **77** [10], 543 (1930).—The Eastern Manufacturers' group of the Structural Clay Tile Assn. recommends that the minimum thickness of panel walls in skeleton frame buildings intended for use as office buildings, hotels, apartments, hospitals, etc., shall be not less than 12 in. in thickness. For skeleton frame buildings not over six stories in height the minimum thickness of panel walls may be 8 in. of approved masonry provided the vertical distance between supports is not over 13 ft. When such walls exceed 13 ft. in height they should be increased 4 inches for each 13 ft. or fraction thereof. E.J.V.

Burial park ornamented with brick. ANON. *Clay-Worker*, **94** [4], 235–36 (1930).—Crown Hill Burial Park, Twinsburg, Ohio, has a 3000-ft. brick wall made of common brick, clinker brick, and face brick seconds. Illustrated. E.J.V.

Brick stadium. ANON. *Brick Clay Rec.*, **77** [10], 527 (1930).—The new Notre Dame stadium at South Bend, Ind., is built of brick because it is colorful, sturdy, and permanent. Illustrated. E.J.V.

Living-room fireplaces. E. AND A. P. STARKEY. *Christian Sci. Mon.*, **22** [281], 8 (1930).—A description of the construction of a "farmhouse type" fireplace, using fireclay brick as the lining and brick similar to the exterior of the house for the exterior of the fireplace, is given. Illustrated. E.J.V.

Uses of clay tile. A. C. FRISK, JR. *Brick Clay Rec.*, **77** [10], 546–49 (1930).—An example of the development of structural clay tile and its application to architectural structures is the new hangar and administration building of Northwest Airways, Inc., St. Paul, at a cost of over $110,000. Details as to the size and construction of the building are given. Illustrated. E.J.V.

Vitrified brick pavement on metal base. ANON. *Dependable Highways*, No. 114, pp. 3–4 (1930); for abstract see *Ceram. Abs.*, **9** [12], 1047 (1930). W.C.O.W.

Brick distinctive as two-course pavement. ANON. *Dependable Highways*, No. 114, p. 2 (1930).—A recent report by the U. S. Bureau of Public Roads on the 18-year Connecticut Avenue (Chevy Chase) experimental road shows the wisdom of a two-course design when Portland cement concrete is the material used in the pavement structure. Although the one-course pavement was much richer in cement content, being a 1:1¾:3 mix, the expense of maintaining it in a serviceable condition was three and one-half times that of the 1:3:7 concrete that was covered with a top course of vitrified brick. W.C.O.W.

Reënforced brickwork. NORMAN W. KELCH. *Brick Clay Rec.*, **77** [9], 483–85 (1930).—Great possibilities lie in this advanced method of brick construction for the brick industry. It is expected that reënforced brickwork will do as much for the in-

creased use of brick as reënforced concrete has done for cement. This is an intelligent exposition of this subject written by a brick engineer who has studied the subject seriously. Some of the research work on this type of construction which is being sponsored by the Clay Products Institute of Calif. is discussed. Illustrated. E.J.V.

Brick industry in Czechoslovakia. O. KALLAUNER. *Stavivo*, p. 665 (1929).—In Czechoslovakia in 1929, there were 2500 brickworks using only handwork, and 550 brickworks using mechanical equipment. The total capacity of this industry was 2,400,000 brick, 29 x 14 x 6.5 cm., and 300,000 tile per year. About 3500 workmen were employed and 700 circular furnaces were used. The two largest plants are (1) Slovakian Brickworks, Ltd., Hodinin, having a capacity of 80,000 brick per year, and (2) Prague Brickworks, Ltd., with a capacity of 60,000 brick. Since 1918 the production of these plants has increased 50% in comparison to 1914. R.B.

Brick trade in U.S. HYNEK OKSNER. *Repts. Czechoslo. Ceram. Soc.*, p. 28 (1928).—O. describes the difference between the brick industry in the U. S. and in Czechoslovakia. The brick industry in the U.S. was an object of discussion of the Brno meeting of Czechoslovakian Ceramic Society, June, 1928. Samples of products of American brickworks were shown to the members. R.B.

Steel lumber for home construction. WILLIAM O. SHELDON. *Brick Clay Rec.*, **77** [9], 492–94 (1930).—The newly-invented hollow steel lumber for use in framework construction is well adapted to brick veneer. Methods of construction and data on tests made on the new material are presented. Illustrated. E.J.V.

Efficient management in brick plants. M. J. BORCHERT. *Tonind.-Ztg.*, **54** [84], 1332–34 (1930).—B. points out the necessity for every brick manufacturer to compile data on the working and operation of his brick plant. This can be done by tables, different kinds of diagrams, and curves. M.V.K.

Primitive brickmaking plant now operating at George Washington's birthplace. GEORGE WASHINGTON BICENTENNIAL COMMISSION. *Clay-Worker*, **94** [4], 244–45 (1930).—A primitive brickmaking plant has been set up and is now running at full capacity turning out brick that are to rebuild the old Washington Mansion. Power for the plant is furnished by a horse, and every step of the process is the same as the original process used in Washington's day. The capacity of the mill at Wakefield is about 4000 brick per day. Illustrated. E.J.V.

Slag brick. B. EVALD AND H. VAGANOFF. *Bldg. Materials*, No. 2, 3 pp. (1930).—E. describes different German and Russian methods for preparing slag brick and points out the high quality of such brick. Data on their properties are given. M.V.K.

Color at British Building Show. ANON. *Brick Clay Rec.*, **77** [9], 500–502 (1930).—The modern use of color in the brick and tile sections of the building industry whereby some attractive effects are obtained in construction work, is amply illustrated by a number of clay products firms at the September-October Building Trades Exhibition at Olympia, London. Some of the various exhibits are described. E.J.V.

Brick hacking machine for handling side-cut brick. FRED R. WETSEL. *Brick Clay Rec.*, **77** [9], 498 (1930).—A brick hacking machine that is simple and practical in design has been perfected. The outstanding feature of this machine is its simplicity. It is designed for operation in connection with stiff-mud machinery and is wholly automatic in operation, requiring only two men, one to supervise the machine and the other to feed pallets into the machine. Illustrated. E.J.V.

PATENTS

Automatic brick machine. JAMES P. MARTIN. U. S. 1,779,136, Oct. 21, 1930. In a brick machine, a casing having a die at one end, a press platen reciprocable in the casing toward and from the die, means for forcing plastic material into the casing be-

tween the die and platen, means for reciprocating the platen including a link having a lost-motion connection with the platen and having parts adjustable to vary the pressure of the platen on material forced thereby through the die.

Brickmaking machine. ROY P. M. DAVIS. U. S. 1,779,209, Oct. 21, 1930. In a brickmaking machine, a mold and mold support, a slicker comprising a slicker bar of substantially the same length as the mold, and means connected to opposite ends of the bar for causing the bar to move across the top of the mold with a translatory circular movement.

Racking machine. ROY P. M. DAVIS. U. S. 1,779,210, Oct. 21, 1930. In a brick-storage loading machine, an elevator having a plurality of spaced racks for supporting pallets thereon, means for delivering loaded pallets continuously to the elevator, a rack car adjacent to and having racks similar to and level with the racks of the elevator, means for elevating the racks of the elevator, a pusher member, means for moving the pusher member forwardly and rearwardly across the vertical path of movement of the elevator racks for simultaneously pushing the loaded pallets from the elevator racks to the racks of the rack car, the pusher member having folding members normally vertically disposed, and means for lifting the folding members to horizontal position as the pusher member starts on its return movement.

Brickmaking machine. ARTHUR JOHNSON. U. S. 1,779,213, Oct. 21, 1930. A brickmaking machine comprising a support adapted to support a mold plate with filled mold thereon, means for causing relative separation in a vertical plane of one edge of the mold from the corresponding edge of the plate, and means for causing relative horizontal movement of the mold and plate whereby the filled mold will be deposited upon the pallet, the operation of the last-mentioned means being entirely independent of the operation of the first-mentioned means.

Metallic insert for brick or tile structures. GEORGE W. DENISON. U. S. 1,781,445, Nov. 11, 1930. In a masonry building wall construction, a metallic building unit, comprising a front member and two end members integrally cast therewith, the members having a continuous flange at the top and bottom thereof; their height and length corresponding to the standard dimensions of the wall building units forming the outer part of the wall, and so placed in the wall and so formed as to have an outer exposed inscription face corresponding in area to the exposed face area of the outer building units in the wall, whereby the wall construction may carry a built-in label portraying the character of the inaccessible unexposed portions of the wall structure.

Drying apparatus. A. MONNIER. Brit. 333,921, Oct. 15, 1930. In a method of drying brick, etc., prior to firing, the drying apparatus is first supplied with air heated by radiation from the oven, and then with air used for cooling the fired products, and lastly with hot gases from the oven. A number of drying chambers are arranged above the oven and communicate on each side through doors with channels which extend along the whole length of the apparatus. The chambers are divided into a number of groups, *e.g.*, six, and a different operation is performed on each group, with a daily change of operation in each group. In the first group the doors are open, and trucks carrying the articles are discharged and charged through double doors in the outer casing. In the second group the doors remain open and moist air stored in the channels during another stage is drawn by a fan through the chambers and through openings to an outlet duct. In the third group the doors are closed, and casings containing a fan and provided with dampers are arranged at the bottom of the doors.

Manufacture of brick, tile, etc., without baking. R. J. LAVAUD AND G. STAS DE RICHELLE. Belg. 363,903, Oct. 31, 1929. Brick is obtained by compression and drying, without baking, of a mixture of SiO_2, Al, Fe_2O_3, tricalcium silicates, Sb sulphide and water. (*C.A.*)

Refractories

Decomposition of refractories. G. G. MARVIN AND W. C. SCHUMB. *Refrac. Jour.*, **5** [57], 352 (1930); for abstract see *Ceram. Abs.*, **9** [9], 786 (1930). E.P.R.

Flux for chemical analysis of fused alumina refractories. EDGAR B. READ. *Jour. Amer. Ceram. Soc.*, **13** [12], 941–43 (1930).—A mixture of sodium carbonate and borax is suggested as a flux for the chemical analysis of fused alumina refractories. The elimination of boron by several evaporations with methyl alcohol was found to be unnecessary.

Control of guaranteed specifications in heat-insulating materials by means of experimental values. J. S. CAMMERER. *Wärme*, **52**, 381–85 (1929).—The values of the heat conductivities of a series of insulating materials are given for temperatures up to 300°C. (*J.I.M.*)

American standards for refractory brick. O. SCHLIEWIENSKY. *Giesserei-Ztg.*, **27**, 37–46 (1930).—Six American standards for refractory brick (Sh 75, H 75, H 57, M 73, H 25, and M 7), and the compositions and testing methods, etc., specified are dealt with fully. (*J.I.S.I.*)

Standards for refractory building materials. ANON. *Tonind.-Ztg.*, **54** [81], 1290–91; [82], 1303–1305 (1930).—The description of the new German standards for refractory materials is given. The refractory materials are (1) silica products prepared from uncombined, mineral silicic acid as main constituent and a setting agent (lime). (2) Products containing alumina: (*a*) limestone, prepared from raw lime only; (*b*) grog products, fired and unfired refractory clay, or only fired clay; (*c*) quartz-grog products prepared from (*a*) or (*b*) with the addition of uncombined silica; (*d*) alumina products, (bauxite, diaspore corundum). (3) Magnesite products. (4) Dolomite, carbon, silicon carbide, chromite, sillimanite, and zirconium. Methods for the chemical analyses, determination of refractoriness, and determination of softening at higher temperature under pressure are given. Methods of determining the specific gravity, volume, total porosity, apparent porosity, absorption of water, resistance to pressure at room temperature, standard sizes of refractory blocks after shrinkage and expansion, resistance against sudden temperature changes, and stability against action of solid and liquid substances at higher temperature are described. M.V.K.

Tests show firebrick properties. FREDERIC B. STEVENS. *Foundry*, **57**, 1012 (1929).—The value of the Seger cone test for determining the refractory properties of fire brick is discussed. (*J.I.M.*)

Simple process for testing refractories. C. P. FERNANDEZ. *Quim. & Ind.*, **7** [75], 91–92 (1930).—A simple method for making a thermal test of refractory products (silico-alumina materials) which gives results sufficiently satisfactory for comparing different classes of refractories is given. The materials necessary are an oxyacetylene blowpipe, a small quantity of quicklime and refractory clay or mortar, and a crucible of graphite or extra-alumina, No. 14 or 16 approximately. After making the thermal test, it is advisable to make a chemical analysis in order to determine the coefficient of Bischoff which is very useful in the study of refractory products:

$$Q = \frac{Al_2O_3 + SiO_2}{Fe_2O_3 + CaO + MgO + Na_2O + K_2O}.$$

All tests are described. M.V.K.

Application of tensile tests to the study of bonding of refractory materials. J. H. CHESTERS AND W. J. REES. *Colliery Guard.*, **141** [3641], 1356 (1930); *Pottery Gaz.*, **55** [641], 1756 (1930).—Some results of tensile tests are recorded for Austrian magnesite (dead burned) bonded with silicate of soda or boric acid, respectively, and for

crushed silica brick bonded with dextrin, alone, and mixed with boric acid, silicate of soda, borax, and soda glass, respectively. It was decided to make an apparatus in which fired or unfired materials could be heated up to 1000°C under tension, and their stability ranges determined. Such tests would be related to cold-tensile tests in the same way as the refractoriness-under-load test is related to the cold-compression test. Results are given for crushed silica brick with dextrin, sulphite lye, or celon (cellulose acetate in very volatile solvents) as bond, and for the same material bonded with a mixture of dextrin with silicate of soda, boric acid, or ball clay. An ideal cement should give strength at all temperatures from that of the air to the highest temperature of the furnace in which it is used. It is suggested that the machine may prove useful in developing and testing cements for furnace work as it should be possible to determine the stability ranges of various materials and, by blending, produce a material with a long stability range. The tensile tests may also be used as a rough test for certain properties of an unknown material, *e.g.*, flux content. E.J.V.

Testing slag erosion of fire brick. ANON. *Engineering*, **128**, 168 (1929).—Dense flint fireclay brick are more resistant to slags containing 0.2% of soda than brick of high alumina content. (*J.I.M.*)

High-temperature crushing test for refractory materials. B. LONG. *Jour. Usines Gaz.*, **53**, 553–57 (1929); for abstract see *Ceram. Abs.*, **8** [6], 425 (1929). (*J.I.S.I.*)

Works tests on refractories and service conditions. R. J. SARJANT. *Colliery Guard.*, **141** [3641], 1356–57 (1930); *Pottery Gaz.*, **55** [641], 1757 (1930).—Universal tests include normal refractoriness, refractoriness under load, and slag attack. Normal refractoriness measures only the action of temperature, rate of heating, and the atmospheric conditions, and is seldom directly related to service conditions, but is a criterion of relative merit between different classes of refractories. Refractoriness under load is more important. The results are shown by curves in which the deformation is plotted against the temperature. The range of deformation temperature is thus obtained. It has been noted that refractories which show satisfactory resistance to spalling, slag attack, and load give useful service in the crowns and arches of forge furnaces and certain smelting furnaces. Other subjects discussed include vitrification, shrinkage, spalling, and heat conductivity. Specific relations between tests and service conditions are considered at length in connection with fire brick, magnesite, dolomite, silica brick, refractory cements, and fire clays. E.J.V.

Quantity of lime in raw paste for silicate brick. A. TAL. *Bldg. Materials*, No. 2, 3 pp. (1930).—T. discusses the quantity of lime in a raw paste for the preparation of silicate brick. This quantity depends on (1) the property of the lime, temperature of firing lime, and the fineness of grinding; (2) the mechanical and chemical composition of the sand, the shape of its grains, and the state of their surfaces; (3) homogeneity of the raw paste; and (4) method of slaking lime. Uncombined lime in a silicate brick increases its solidity which increases in proportion to its uniform distribution in the brick especially in the spaces between the grains. M.V.K.

Tests on Dinas and grog blocks. OSKAR LECHER. *Bldg. Materials*, No. 4, 5 pp. (1930).—L. discusses different tests made to ascertain the stability of refractory blocks to the action of slag and fused glass and describes his investigations on this question. A series of grog blocks, the chemical composition of which is given, were tested in a gas kiln in which a grog crucible with holes at the bottom was put. The samples for testing were put into the heated crucible. The crucible was filled with a batch and the required temperature maintained. The fused glass dropped slowly from the bottom into water. Every 15 minutes the crucible was filled with the batch in order to keep the samples covered by the fused glass. For 3 hrs. the samples were subjected to the action of fused glass, then they were slowly cooled in a kiln. The samples were broken

into two parts and were investigated. This method is simple and the test blocks can be heated to the different temperatures required. The glass paste flowing from the crucible can also be investigated to ascertain the action of the Dinas and grog blocks on the glass paste. M.V.K.

Production of Dinas blocks in U.S.S.R. P. P. BUDNIKOFF. *Bldg. Materials*, No. 1, 10 pp. (1930).—B. describes tests made on Dinas blocks and brick. The composition of quartzites and Dinas used is given. The results of tests are given in curves and tabulated, and show that the properties of Russian Dinas blocks are not lower than of those prepared abroad. M.V.K.

Silica and magnesite brick. ANON. *Technique Moderne*; *Jour. four élec.*, **39**, 59 (1930).—The manufacture, properties, and uses of silica and magnesite brick are given. (*S.S.*)

Softening fireclay stones in fire under pressure. F. KANHÄUSER. *Repts. Czechoslo. Ceram. Soc.*, p. 174 (1924).—K. gives a survey of the results of the tests undertaken to investigate the influence of slate admixture on the softening in fire, as well as the behavior of various Czechoslovakian argillaceous refractory earths ungreased with various kinds of Czechoslovakian slates. Illustrated. R.B.

Some properties of quartz-clay mixtures. ANON. *Trans. Inst. Gas Eng.*, p. 434 (1926–27).—An investigation of the load-bearing capacities of various mixtures of Stourbridge clay and quartzite brought to light that below 200°C is a dangerous range of temperature with used siliceous material. (*J.I.M.*)

Load-bearing capacity of siliceous products at high temperatures. ANON. *Trans. Inst. Gas Eng.*, p. 433 (1926–27).—Chemical composition must be regarded as subsidiary to physical composition, since grain size of quartzitic particles exerts a profound effect on their behavior under load at high temperatures. (*J.I.M.*)

Transformation heat of quartzite and its thermal expansion behavior at the transition point (575°) with special reference to the quality of quartzite for silica brick. Y. TADOKORO. *Abstracts of Papers, World Eng. Congress* [Tokyo], *Paper* No. 83 (1929); *Building Sci. Abs.* [*N.S.*], **3**, 161.—The quality of some quartzites used for silica brick is discussed with special reference to the transformation heat and expansion coefficient at 573°. The heats of transformation of all the quartzites used in Japan in the manufacture of silica brick have been measured by the usual calorimetric method. Slag corrosion and service tests have been conducted in an open furnace with silica brick made of 3 typical kinds of quartzite. The value for the increase of the expansion coefficient at 573° has been measured for 10 different quartzites by means of apparatus devised by T. It has been reported that silica brick made of flint quartzite are much superior to those made from sand quartzite when used in open furnaces. The expansion at the critical point occurs suddenly for the sand quartzite, while it occurs slowly for the flint variety; further, the transformation heat of the former is twice that of the latter. The flint quartzite also shows less tendency to spalling than the sand. (*C.A.*)

Effect of repeated firing on structure and properties of lime-bonded silica brick. II and III. W. HUGILL AND W. J. REES. *Colliery Guard.*, **141** [3641], 1357 (1930).—Part II is concerned with the determination of the proportions of quartz, cristobalite, and tridymite present in the brick after repeated firings. Up to the third firing the proportion of unchanged quartz fell rapidly, but afterward, much more slowly. Tridymite increased rapidly and cristobalite decreased rapidly to the sixth firing, but at a lower rate afterward. The brick contained 7.9% by volume or 9.1% by weight of quartz after eleven firings. The results emphasize the importance of the high-temperature soaking period in firing silica brick. Part III deals with the determination of the reversible thermal expansions which are shown in plotted curves. After one firing the change from one variety of quartz to the other is quite noticeable on the expansion

curve, but after three firings the curve shows only a very small bend from this change. For Part I see *Ceram. Abs.*, **5** [7], 218–19 (1926). E.J.V.

Effects of furnace atmosphere upon refractory materials. A. E. J. VICKERS. *Trans. Inst. Gas Eng.*, pp. 426–33 (1926–27).—A few observations on the combined effect of temperature and furnace atmosphere on refractories are given. V. finds that at temperatures over 1150°C, and in the presence of alumino-siliceous material, water vapor has greater reducing properties for the oxides of iron than has hydrogen itself. (*J.I.M.*)

Gas permeability of refractory brick used in metallurgical furnaces. F. N. WICKENHAM. *Refrac. Jour.*, **3**, 710–12 (1928); for abstract see *Ceram. Abs.*, **8** [6], 425 (1929). (*J.I.M.*)

Influence of atmosphere on load-bearing capacities of fire brick. H. T. S. SWALLOW. *Colliery Guard.*, **141** [3641], 1356 (1930); *Pottery Gaz.*, **55** [641], 1757 (1930).—The refractoriness, refractoriness under load of 50 lb. per sq. in., true and apparent porosities, and powder specific gravities of five representative commercial fire brick are tabulated. Analyses of the furnace atmosphere during standard load test indicated absence of carbon monoxide and presence of free oxygen at temperatures up to 1550°C. Reducing conditions were secured by pouring coal gas into the furnace. Brick were tested with steam blown into the furnace. It is suggested that the influence of a reducing atmosphere on fire brick in high-temperature furnaces is apparent more in an increase in the amount of contraction than in a reduction in refractoriness or load-bearing capacity. Definitions of the terms "oxidizing" and "reducing" considered in connection with the influence of furnace atmospheres on refractories are suggested. The atmosphere of the Hirsch type load-test furnace has been found to be oxidizing. At the temperatures at which these experiments were made (1200 to 1280°C) the action of steam appears to be negligible compared with that of a strongly reducing atmosphere. The importance of taking into account the iron content of fire brick when considering the results of tests made under oxidizing conditions becomes apparent. E.J.V.

Influence exerted by degree of grinding of grog on strength of refractory products. N. NAPALKOFF. *Tonind.-Ztg.*, **53**, 1365–67 (1929).—The fusion point of fine-grained material is lower than that of more coarse-grained material. Grains larger than 0.3 mm. in diameter have practically no effect on the fusion point. The shrinkage increases with the fineness of the grain but decreases inversely with the percentage of grog. The fineness of the grog has a greater influence than the degree of thinning. The porosity increases with the grain size and the grog content. Fine-grained materials resist crushing the best; the contact between chamotte and clay is better and the mass is homogeneous. For a given fineness leaner materials are less resistant. The resistance to attack by glass (25 to 30% alkali carbonates) rises with the compactness, with the fineness of the grain, and with the grog content. (*J.I.S.I.*)

Grog and its functions. C. R. F. THRELFALL. *Colliery Guard.*, **141** [3641], 1356 (1930); *Pottery Gaz.*, **55** [641], 1756–57 (1930).—The use of the term "grog" was at one time reserved to describe any material of a nonplastic nature which served the purpose of keeping the texture of a brick open. Grog is no longer merely a diluent of fire brick and saggers. In super-quality refractories it forms the major portion of the body, and even in lower quality materials it is being used in ever-increasing quantities. T. would define grog as "any matter present in a wet batch in a nonplastic or comparatively nonplastic form." The definition should include any nonplastic material or materials with less shrinkage, either in the drying or firing stages, than the clay embodied in the mass. Grog could be divided into three types, porous, nonporous, and "green" grog. The porous includes calcined fire clays, broken fire brick, and saggers. The nonporous includes corundum, sillimanite, ground quartzite rocks, sand, and such

materials as Ayrshire bauxitic clays. Problems in the manufacture of heavily grogged fire clay including batch preparation, grinding, mixing, tempering, and pugging are dealt with. E.J.V.

Pneumatic preparation of grog blocks. V. I. RIBNIKOFF. *Ceramics & Glass*, **6** [6], 315–17 (1930).—Investigations were made on the use of pneumatic hammers for the preparation of grog blocks. The materials used are given and tests described. These tests showed that blocks molded by pneumatic hammers are of high quality. They are dense and their mechanical solidity is great. The latter can be raised by increasing the firing temperature up to SK 14 (1410°). M.V.K.

Setterberg porous refractory and insulating brick. ANON. *Ind. Chemist*, **5**, 422 (1929).—A description is given of a new method of manufacture of porous refractory brick, which is carried out by mixing some finely-powdered refractory material with aluminium powder and water to the consistency of a plastic dough. Gas is evolved by contact of the aluminium with water, and after this process of "fermentation" the mixture is shaped into blocks which are dried and then fired at high temperatures. The brick have a high insulation value; they soften at 1655°C and fuse at 1680°C. (*J.I.M.*)

Compact texture of refractory oxides and high-temperature furnaces with oxidizing atmospheres. H. SALMANG AND H. BRORS. *Ber. deut. keram. Ges.*, **10**, 429–45 (1929).—The refractory properties of magnesia alone and in admixture with silica, yttria, zirconia, glucinium oxide, alumina, and didymium oxide, with the addition of suitable binders were examined and are recorded in tables and graphs. The difficulties encountered in firing at very high temperatures while maintaining an oxidizing atmosphere are discussed, and the construction of a special furnace is described. (*J.I.S.I.*)

Kureika graphite. ANON. *Sprechsaal*, **63** [41], 778 (1930).—Large deposits of graphite on the river Kureika in Siberia were discovered. The average thickness of the deposits is about 15 m. The Kureika graphite contains from 80 to 98% carbon. The properties are compared to those of Korean and Mexican graphite and show the superiority of the Russian graphite. M.V.K.

Manufacture of carborundum and aloxite. ANON. *Ind. Chemist*, **6**, 321–24 (1930).—The Manchester, England, plant of the Carborundum Co., Ltd., is described. Photographs are included. H.H.S.

Silicon carbide and electrite. V. JUST. *Repts. Czechoslo. Ceram. Soc.*, p. 201 (1924).—In Czechoslovakia, silicon carbide works were founded in the years 1894 to 1895 in Staré Benátky. Czechoslovakia was the first country to produce grinding wheels of silicon carbide. In 1896, for the first time, Czechoslovakian works produced artificial corundum. The Czechoslovakian market absorbs only 25% of the home production, the remainder being exported. A branch factory is at Dresden, Germany. Raw materials used are 60% SiO_2, 40% C, 6 to 10% saw dust, and 8 to 12% NaCl. The current required for the production of 1 kg. silicon carbide is 13 to 16 kw.-hr.: for 1 kg. corundum, 3 to 5 kw.-hr. R.B.

Corundum and silicon carbide. R. SCHNEIDLER. *Chem.-Ztg.*, **54**, 625–27 (1930).—Batch working is preferred in the electrothermic manufacture of corundum because the removal of the impurities in the bauxite is easier and the physical structure of the product better. Furnaces are usually constructed of strong sheet iron, unlined, as the slag forms an excellent protection. The floor is covered with tar, coal, etc. Coke is laid upon this and the bauxite gradually added and melted by moving the electrodes by hand or automatically, the current being kept at 6000 amp. and 90 to 120 volts. After completion of the process the cooled block of corundum is lifted out vertically. The usual yield is 55 to 60% of first-class corundum, calculated on bauxite. The usual corundum of commerce contains 95 to 97% Al_2O_3; inferior qualities are darkened in

color by iron and titanium. Silicon carbide is produced by the reduction of quartz sand containing at least 98% SiO_2 with good-quality coke or anthracite at 1800°. It is decomposed by heating to 2200°, such decomposition being catalyzed by the presence of iron or other metals, which must therefore be excluded as far as possible. A resistance furnace built of refractories with a resistor core of coke is used and the current must be kept uniform. (*B.C.A.*)

Thermal expansion of chromite. ANON. Bur. Stand., *Tech. News Bull.*, No. 160, pp. 78–79 (1930).—Several samples of chrome ore are included in the Bureau's investigation of the linear thermal expansion of special refractories to 1800°C. Some data on expansion of Imperial (Rhodesian), African (friable), Grecian, and Indian chrome ores have been obtained. The ores all have the same characteristic expansion, *i.e.*, when tested from 20 to 1000°C in a neutral to oxidizing atmosphere the rate of expansion of specimens fired at cone 23 (approximately 1580°C) is uniform throughout the entire temperature range and the total expansion at 1000°C is between 0.7 and 0.85%. Under reducing conditions, however, the rate of expansion increases greatly and in the case of the African ore the increase is enormous. For comparative purposes the following table gives the average coefficient of expansion from 20 to 1000°C:

Kind of Ore	Atmosphere Used	
	Oxidizing	Reducing
Imperial Chrome	7.29×10^{-6}	17.45×10^{-6}
African "	8.51×10^{-6}	39.01×10^{-6}
Grecian "	8.32×10^{-6}	10.06×10^{-6}
Indian "	7.29×10^{-6}	15.91×10^{-6}

The total expansion of the African ore was 4.8% at 1030°C (reducing atmosphere). The cooled specimen had increased 4.3% in length. The maximum expansion (reducing atmosphere) of the Imperial ore was 1.93% obtained at 1200°C; the Grecian ore 1.16% also obtained at 1200°C and the Indian ore 1.83% obtained at 1300°C. The Imperial ore fired at cone 23 and also heated to 1800°C showed on a second testing a maximum expansion of 1.20% obtained at 1430°C. The average coefficient of expansion from 20 to 1430°C is 8.5×10^{-6}. R.A.H.

Sillimanite refractories. ANON. *Brit. Refrac. Research Assn., Bull.*, No. 14; *Trans. Inst. Gas Eng.*, pp. 428–33 (1926–27). (*J.I.M.*)

Special refractories. E. H. SCHULZ AND A. KANZ. *L'Industrie Chimique*, **17** [197], 410 (1930); for abstract see *Ceram. Abs.*, **9** [5], 358 (1930). (*S.S.*)

Refractories. R. M. DOIDGE. *Eng. Rev.*, **42**, 413–14 (1929); for abstract see *Ceram. Abs.*, **9** [5], 355 (1930). (*J.I.M.*)

New viewpoints in evaluation of refractory materials. W. M. COHN. *Metallwirtschaft*, **8**, 1163–68, 1191–94 (1929).—C. reviews various types of refractories used in the ceramic and other industries and describes the method of manufacture and their characteristic properties. Special attention is paid to the refractories used in the iron and steel industry. (*J.I.M.*)

Observation on the effect of silicon carbide in clay bodies. S. F. WALTON AND E. L. HAUMAN. *Jour. Amer. Ceram. Soc.*, **13** [12], 935–40 (1930); for abstract see *Ceram. Abs.*, **9** [3], 191 (1930).

Fire clays: some fundamental properties at several temperatures. R. A. HEINDL AND W. L. PENDERGAST. *Blast Fur. Steel Plant*, **18** [11], 1735–36 (1930); Bur. Stand., *Jour. Research*, **5** [2], 213–36 (1930); see also *Ceram. Abs.*, **9** [11], 939 (1930). E.J.V.

Progress report on investigation of fireclay brick and clays used in their preparation. R. A. HEINDL AND W. L. PENDERGAST. *Blast Fur. Steel Plant*, **18** [11], 1735 (1930); *Brick Clay Rec.*, **77** [9], 499 (1930); Bur. Stand., *Research Paper*, No. 114; see also *Ceram. Abs.*, **9** [1], 39 (1930). E.J.V.

Properties of silica and fireclay products in relation to their industrial usage. A. T. GREEN. *Trans. Inst. Chem. Eng.*, **5**, 192–210 (1927); for abstract see *Ceram. Abs.*, **7** [7], 459 (1928). (*J.I.M.*)

Protecting surface of refractory brick. J. HAUSEN. *Wärme*, **52**, 213–15 (1929).—Refractory brick may be protected from the action of hot-flame gases and coal dust by painting the surface with alumina, chromite, or zircon materials, the choice depending on the purpose in view. The joints between the various brick should be filled in with similar material. (*J.I.M.*)

Alumina in steel furnace linings. G. MARS. *Metallurgist*, **6**, 4–5 (1930); for abstract see *Ceram. Abs.*, **9** [5], 358 (1930). (*J.I.S.I.*)

Heat economy in metallurgical furnaces. R. HADFIELD AND R. J. SARJANT. *Fuel Sci. Practice*, **9** [5], 219–24 (1930).—The loading of metallurgical furnaces is discussed in relation to the convenient modes of studying its influence for the purposes of control of heat economy, and its bearing on the best forms for new construction. Instances from works practice are indicated which demonstrate quantitatively the advantages of control of rate of fuel supply and, in particular, of automatic means of control. The application of heat-resisting steel to recuperator practice is discussed, and an instance of its successful application to the heating of primary air in coal-fired furnaces is described. Brief allusion is made to the study of heat exchange in regenerators. The possibilities of heat-resisting alloys in regenerators are reviewed, and in particular in the moving regenerator, which in a fabricated form permits the minimum utilization of material for heat storage and exchange. R.G.M.

Determining heat transfer in recuperators. J. G. COUTANT. *Eng. & Finance*, **21** [4], 197–99 (1929).—C. explains heat transfer phenomena and presents charts which enable the user to determine heat transfer in recuperators more accurately. R.G.M.

Furnace linings. A. E. BARTLETT. *Eng. & Finance*, **22** [2], 46 (1930).—A plant operating two 422-b.h.p. Stirling boilers fired with Type E stokers experienced serious clinkering at the fire line of the side walls. Slice bars were used every few hours. The work was hard and disagreeable, causing labor trouble. Open doors let air enter above the fire causing fuel loss. Carbofrax brick were installed and it was found that the clinker did not adhere. The life was increased from 10 weeks to 15 months. The annual saving per boiler amounted to $295.75. The net return on added brick cost was 62%. Additional benefits were (1) increased fuel economy due to no entry of air over the fire and (2) reduced labor turnover in the boiler room. R.G.M.

Manufacture of refractory brick. H. E. TOWNSEND. *Heat Treating & Forging*, **16**, 193–95 (1930); for abstract see *Ceram. Abs.*, **9** [4], 282 (1930). (*J.I.S.I.*)

Advances in refractory field in U.S. in 1928. W. STEGER. *Feuerfest*, **5**, 69–75 (1929). (*J.I.M.*)

Refractory materials for foundries. W. M. COHN. *Giesserei-Ztg.*, **26**, 588–93, 614–19 (1929); *Metals & Alloys*, **1**, 478.—The main viewpoints which are to be considered in selecting the best suited refractory materials for furnaces, are summarized. Chemical and physical properties, test methods, and apparatus are described. With especial emphasis on the behavior in heating and cooling, specific heat, heat expansion, heat conductivity, softening under pressure, stability toward changing temperatures and extreme high temperatures, stability toward attack of slags, dust, and gases are dealt with. The application of refractories for cupolas is discussed. (*C.A.*)

Material for gas retorts. ALFRED B. SEARLE. *Gas Eng.*, **47**, 413–14 (1930).—Selection of retorts and retort materials must be made in conjunction with a knowledge of the precise conditions under which the retort is to be used. Molded retorts must be made largely of clay. For continuous retorts of the vertical or coke-oven type SiO_2 brick appear preferable to any other because of their higher thermal conductivity and

greater resistance to salt present in many damp coals. Disadvantages of SiO_2 are high coefficient of expansion and sensitiveness when cooled. The nearer the specific gravity of the powdered SiO_2 brick approaches 2.27 the more satisfactory is the brick likely to be. (*C.A.*)

Developing North Carolina cyanite. H. J. BRYSON. *Brick Clay Rec.*, **77** [9], 474–81 (1930); *Blast Fur. Steel Plant*, **18** [11], 1736–42 (1930); for abstract see *Ceram. Abs.*, **9** [12], 1092 (1930). E.J.V.

BOOKS

Clinker: Its Preparation and Use. (Die Klinker für technische Verwendungszwecke, ihre Herstellung und Verwendung.) FELIX NIEBLING. Wilhelm Knapp, Halle, 1930. Rm. 3.75. Reviewed in *Sprechsaal*, **63** [40], 770 (1930).—N. describes different kinds of clinker for technical use, the raw materials and their preparation, shaping, drying, and firing. Illustrated. M.V.K.

Graphite. OSCAR KAUSCH. Reviewed in *Mining & Met.*, **11** [287], 10 (1930); for abstract see *Ceram. Abs.*, **9** [12], 1059 (1930). E.J.V.

Institutes for Testing Refractory Materials. L. LITINSKY. Reviewed in *Chem. Met. Eng.*, **37** [10], 639 (1930); for abstract see *Ceram. Abs.*, **9** [11], 947 (1930). G.R.S.

Refractories. SEABOARD REFRACTORIES CO. 14 pp. Reviewed in *Blast Fur. Steel Plant*, **18** [11], 1735 (1930); see also *Ceram. Abs.*, **9** [12], 1059 (1930). E.J.V.

PATENTS

Furnace roof. ENOCH P. STEVENS. U. S. 1,778,776, Oct. 21, 1930. A furnace-roof bung unit comprising a girder adapted to be spanned between supports at the furnace side walls; a bung of refractory brick with the brick freely suspended from the girder; and yielding means carried by the girder for exerting pressure on the bung ends to compensate for expansion and contraction of the brick and maintain tight joints between them.

Manufacture of refractory material. JEGOR ISRAEL BRONN. U. S. 1,780,114, Oct. 28, 1930. A process for the manufacture of highly-refractory material adapted to form solid blocks when heated, consisting in mixing calcium aluminate cement with chromium ore.

Repairing heated structures such as furnaces, retorts, etc. ARTHUR MCDOUGALL DUCKHAM. U. S. 1,780,120, Oct. 28, 1930. Apparatus for repairing a crack in a heated structure of the kind referred to comprising in combination a container for a charge of repairing material having an open mouth, means for holding an explosive charge in the container behind the charge of repairing material, means operable from the outside of the structure to be repaired for introducing the container into the structure and presenting its mouth substantially to a crack in the structure and means for exploding the explosive charge.

Coking retort oven. JOSEPH VAN ACKEREN. U. S. 1,780,803, Nov. 4, 1930. A coke-oven battery having side by side coking chambers with intermediate heating walls, characterized by heating walls individually having at least two groups of inflow flues and at least two groups of outflow flues, with a bus flue connecting an inflow group with an outflow group, combined with pairs of inflow and outflow regenerators, each pair of regenerators being connected with a similarly operating group of flues of each of the two heating walls on the opposite sides of an intervening coking chamber.

Refractory material. TURE R. HAGLUND. Fr. 683,465, Oct. 17, 1929. A refractory material is principally composed of oxides of Mg, Al, and Cr, while the oxides of Si, Fe, and Al are present in amounts such that the total of oxides of Si and Fe and the

excess of Al_2O_3 over the amount of Cr_2O_3 is not above 60. Three examples are MgO 52, 27, 26, Cr_2O_3 9, 20, 40, Al_2O_3 18, 40, 17, SiO_2 13, 6, 8, FeO 1, 1, 5, CaO 6, 3, 3, and TiO—, 2, —parts. (*C.A.*)

Method for binding highly-refractory materials. STETTINER CHAMOTTE FABRIK. Ger. 501,189, Jan. 21, 1927; *Tonind.-Ztg.*, **54** [75], 1219 (1930).—By using a setting agent consisting of an acid and its corresponding salt for binding pure highly-refractory masses, *e.g.*, pure zirconium oxide or dioxide, pure aluminium oxide, silicon carbide, etc., it was observed that the solidity of these masses is already considerably increased in unfired pastes when small additions of other highly-refractory materials, which have a greater affinity with the setting agent than with the refractory materials used, are added to the ground pastes. Pure zirconium oxide or dioxide is very inert and produces less solid masses with the setting agent before heating to redness, *e.g.*, zirconium oxide with impurities of iron oxide. Only such materials are used, and in such small quantities, that the fusing point is not lowered appreciably. It was found that pure chromic oxide, graphite, and carbon combine well with the setting agent. An addition of 0.5 up to 1% chromic oxide, graphite, etc., to the pure highly-refractory minerals is sufficient, and very inert substances can be hardened into quite solid masses even in their cold state in this way. M.V.K.

Terra Cotta

Servicing of kiln cars. H. SPURRIER. *Jour. Amer. Ceram. Soc.*, **13** [12], 929–30 (1930); for abstract see *Ceram. Abs.*, **9** [3], 204 (1930).

"Lock-keyed" terra cotta. J. R. GWYNN. *Brick Clay Rec.*, **77** [9], 469–70 (1930).—"Lock-keyed" terra cotta came into being in response to the present-day demand for rigid economy in building costs. Regular terra cotta which, of course, is the better all-around purpose material, is approximately 4 in. thick and averages 26 lbs. to the square foot. "Lock-keyed" terra cotta approximates $1^1/_4$ in. in thickness and averages but 15 lbs. to the square foot. The limitation of "lock-keyed" terra cotta is that the builder is tied down to vertical lines in his structure as the slabs of "lock-keyed" terra cotta are upright and are practical to use only in such buildings as will permit the use of tile in vertical position. "Lock-keyed" tile is all made mechanically, exuded from a specially made vertical clay press die with dovetailed slots cut in the core of it, usually three or four slots to each slab. The ashlar tile is made in hollow squares of the desired width and length and scored at the proper places so that, after firing, it can be split. The pier tile is made in clusters of two or three, in hollow-cylinder form, approximately, and scored so as to split easily after firing. After breaking apart, the four edges of each slab are shaped in a special grinding machine. Illustrated. E.J.V.

Acid-proof ceramic products. P. P. BUDNIKOFF. *Bldg. Materials*, No. 4, 6 pp. (1930).—Acid-proof ceramic products must be resistant to hydrochloric, sulphuric, nitric, and other acids at different temperatures. These products are of two kinds: (1) coarse products used in the chemical industry, grog blocks and brick fired to vitrification; and (2) fine objects used in chemistry. The body of an acid-proof product must be homogeneous and dense; its surface is generally glazed. Its porosity must not exceed 1 to 1.2%. Grog rich in alumina or silicic acid can be used for acid-proof objects. The thermal stability of the material depends on the volume of pores, and the amount and size of the grog grains. Special materials are also used, *e.g.*, silicon carbide, zirconium oxide, and other oxides. Magnesite, chromic, and graphite blocks are also acid-proof, depending on their structure. As raw materials for the preparation

of acid-proof objects, the average plastic-refractory clays can be used. To decrease shrinkage, grog powder made of the cullet of acid-proof products can be used. To lower its vitrification temperature, feldspar alkalis containing easily fusible substances, and powdered quartz sand can be used. Drying and firing acid-proof objects must be carefully regulated; fine objects are fired in saggers. The temperature of firing is from 1250 to 1280° depending on the composition. The objects are especially sensitive when cooling from 700°; their critical temperature is about 550° and 250°. Russian clays which can be used for the preparation of acid-proof objects are described. M.V.K.

Face tile with fritted glaze face. S. F. HECKERT. *Brick Clay Rec.*, **77** [9], 468 (1930).—The National Fireproofing Co. is offering a fritted glaze face tile made in seven mottled effects and solid colors including white, black, and shades ranging through cream tan to cream brown. Natco's frit is made of a number of various compounds which are mixed, melted at 2300°F, chilled, and then ground to an impalpable powder. The successive coats of glaze material are applied to the tile on a patented "G Mottling" machine. When the tile are fired, the frit causes the glaze to mature at a lower temperature, forms an intimate bond with the tile and yields a silica glaze equivalent to that on the finest English glazed brick. Due to its immunity to acids, to alkalis, and the attack of the elements, the Natco fritted glaze vitritile is recommended for both exterior and interior use. E.J.V.

Glaze discovery. A. J. HOLDEN. *Brick Clay Rec.*, **77** [10], 562 (1930).—It was discovered that by the addition of a small amount of fluxing agent the Niobrara shale from which the Parco (Wyo.) brick in buff and green shades are fired becomes an excellent glazing material. The Niobrara shale has a low fusion point in the natural state and is self-glazing at about 2000°F, but the brick deform if heated to this temperature. By fine grinding and the addition of a small quantity of fluxing material a glazing agent is made which, brushed on a brick or vase, forms a "glass" at about 1700°F. E.J.V.

Controlling the manufacture of stoneware. ANON. *Corriere ceram.*, **11** [9], 371–75 (1930).—The control of the manufacture of stoneware includes (1) a great many tests relative to raw materials, (2) the behavior of the products at different stages of manufacture such as shaping, drying, and firing, (3) properties of the fired product, (4) methods of working, (5) mechanical installations, (6) kilns, (7) fuels, etc. Some of the most important of these questions are studied. M.V.K.

Manufacture of stoneware. III. T. W. TALWALKAR. *Jour. Indian Ceram. Soc.*, **2**, 83–97 (1930).—The cost of materials and various processes of manufacture are discussed. For Parts I and II see *Ceram. Abs.*, **9** [9], 752; [10], 856 (1930). A.A.

Sound absorption coefficients. ANON. Bur. Stand., *Tech. News Bull.*, No. 161, p. 88 (1930).—Data are given which were recently obtained by the Bureau, for the sound absorption coefficients of a number of materials now on the market as acoustic correctives. The results given cover (1) lime plaster panels, (2) Acoustex, painted, and (3) laminated acoustic tile. R.A.H.

German "Feuertonwaren." ANON. *Corriere ceram.*, **11** [9], 89 (1930).—The "Feuertonwaren" of Germany are ceramic products of a type of majolica composed entirely of clay, the plastic element being supplied by raw clay and a nonplastic of the same clay fired. The latter is known as "chamotte" and is used in grains of 0.5 mm. or more for larger pieces. They are chiefly for sanitary use. The paste has the following composition: nonplastic clay 20, fat clay 15, raw kaolin 20, "chamotte" of Caselle 45. The engobe has the following composition: washed kaolin 30, ball clay 20, quartz sand 42, feldspar 8. The glaze applied when the engobe has dried is composed of 111.8 feldspar, 12.2 zinc oxide, 8.4 red lead, 93.0 plastic clay, and 150.0 silica. M.V.K.

White Wares

Impact properties of china. EDWARD SCHRAMM AND F. P. HALL. *Jour. Amer. Ceram. Soc.*, **13** [12], 915–22 (1930); for abstract see *Ceram. Abs.*, **9** [3], 209 (1930).

Use of autoclave in testing ceramic products for resistance to crazing. R. G. MILLS. *Jour. Amer. Ceram. Soc.*, **13** [12], 903–14 (1930); for abstract see *Ceram. Abs.*, **9** [3], 207 (1930).

Advantages and use of CO_2 meter on forced downdraft periodic kiln as to temperature distribution. D. M. MCCANN. *Jour. Amer. Ceram. Soc.*, **13** [12], 944–46 (1930); for abstract see *Ceram. Abs.*, **9** [3], 211 (1930).

Further studies of "moisture expansion" of whiteware. ANON. Bur. Stand., *Tech. News Bull.*, No. 161, p. 91 (1930).—An endeavor is being made to determine the nature of the reaction manifested by an increase in volume when water-permeable ceramic bodies are subjected to moisture. The minimum temperature at which the moisture causing this expansion can be removed from the body and the accompanying contraction completed should indicate whether or not actual hydration has taken place. This minimum temperature was determined. Specimens of three commercial bodies were tested. Although the specimens were dried to constant weight at 110°C before the autoclave treatment, the loss in weight when held at temperatures of 120° and higher exceeded the gain in the autoclave. The gain in the autoclave varied from about 10 to 15%, while the weights after the heat treatments were from 0.0 to 0.7% less than the original weights after drying at 100°C. The specimens continued to lose weight up to approximately 250°. The greatest contraction in volume due to the elimination of moisture was obtained by holding a specimen at 240 to 250°C for 5 hours and equaled 0.075%. R.A.H.

Cost of feldspar. C. R. AMBERG. *Jour. Amer. Ceram. Soc.*, **13** [12], 923–26 (1930); for abstract see *Ceram. Abs.*, **9** [3], 210 (1930).

Casting clay ware. F. P. HALL. *Pottery Gaz.*, **55** [641], 1770–72 (1930); for abstract see *Ceram. Abs.*, **9** [11], 951 (1930). E.J.V.

Approved simplified practice recommendation on floor and wall tile. ANON. *Keramik Tile Jour.*, **2** [9], 31–62 (1930); for abstract see *Ceram. Abs.*, **9** [12], 1065 (1930). W.C.O.W.

Rate of vitrification of porcelain. C. W. PARMELEE AND A. E. BADGER. *Ind. Eng. Chem.*, **22** [7], 781–85 (1930).—Samples of a typical porcelain body were fired in an electric furnace under different conditions of temperature and time. Measurements of the total porosities and the volume changes showed that both of these properties increased in magnitude when the body was fired and then decreased at a regular rate until maturity was attained. The time rates at which these changes took place were proportional to the temperature of the heat treatment of the porcelain. The variations are shown to be in accord with the known transformations which occur when a porcelain body is fired. The results may aid in the study of commercial firing schedules. R.G.M.

Decorated porcelain and washing machines. ANON. *Sprechsaal*, **63** [43], 824 (1930).—Tests were made to determine the action of alkaline fat-dissolving washing agents on porcelain as used in homes. It was found that porcelain and gold and colored decorations are strongly affected when the temperature of the wash and rinsing water is about 80° as it is used in washing machines. Washing agents containing scouring substances can damage porcelain at lower temperatures. M.V.K.

Porcelain as material for industrial use. E. MOSER. *Quim. & Ind.*, **7** [78], 181–82 (1930).—The mechanical, thermal, and electrical properties and the temperature limits of glazed and unglazed porcelain test pieces are given to show that porcelain is a

material especially appropriate for laboratory utensils and apparatus for the chemical industry. M.V.K.

Development of the porcelain insulator. K. A. HAWLEY. *Jour. Amer. Inst. Elec. Eng.*, **49**, 796–99 (1930). (*C.A.*)

Paving and wall tile. KAREL HINEIS. *Repts. Czechoslo. Ceram. Soc.*, p. 164 (1924).—A historical survey is presented. R.B.

Dutch tile stoves. KAREL HINEIS. *Repts. Czechoslo. Ceram. Soc.*, p. 216 (1924).—A perfect living-room heating equipment must fulfill the following conditions: (1) make the rooms sufficiently warm even at the coldest outside temperature; (2) develop as far as possible a uniform temperature throughout the living rooms so that the temperatures at the floor and near the ceiling differ only a few degrees; (3) permit the temperature and heat to be regulated as required; (4) be ready for use immediately in every season and in a day's time; (5) develop heat immediately and for a long time as far as possible, permanently; (6) emit only moderate heat, which should not go over 80°C; (7) heat and ventilate at the same time; (8) work economically, *i.e.*, the service must be as cheap as possible; and (9) handling should be as simple and as clean as possible. On the contrary the stove ought not to have the following properties: (1) radiate too violent and disagreeable a heat; (2) burn the deposit of dust on the surface whereby the air in the room would be spoiled; (3) be in action without will or need. The above conditions are numerous and even contradictory. Suitably designed Dutch tile stoves, however, can fulfill all these conditions. H. indicates the calculation of proper dimensioning the stove for a given room, describes the shape of tile, their glazing, the interior construction of the stove, and especially the flues and air-inlet apertures. R.B.

Crazing of earthenware. ARTHUR HEATH. *Pottery Gas.*, **55** [641], 1757 (1930).—A range of bodies was made up of clay, flint, and Cornish stone (2 parts hard purple and 1 part dry white) varying from 4 flint, 28 stone, and 68 clay to 64 flint, 4 stone, and 32 clay. In all, 90 bodies were made up, and the composition of each body in terms of silica, alumina, and bases was calculated. The contraction and the porosity of each body and the various temperatures to which they were fired were carefully recorded in tabular form. It was noted that the temperature for bodies fired in an earthenware biscuit kiln varied between cone 2 and 7. It was evident that in compounding a body it must be so made that it is safe from crazing at the lowest temperature. High temperature invariably lowered the crazing area, though in one or two cases this was shown to increase the liability to peeling. There were only five bodies with under 70% silica which did not craze but it was found on careful examination that many bodies with over 70% silica were not safe, for even though they did not craze they entered the peeling zone. It became apparent as the work proceeded that the crucial factor was not the 70% silica but the quantity of the bases. None of the bodies containing below 2.5% of bases were safe at all, irrespective of what the percentage of silica was. H gives as his choice of a reliable body, consistent with bringing the ware out safe, the following: clay 47.5, flint 32.5, stone 20, which is equal to 73% silica, 23.5% alumina, and 3.5% bases. The glaze used was a standard, low-solubility glaze, and the trials were based on firing in easy and hard glost. E.J.V.

Heat theory of electrical breakdown. V. A. FOCK. *Trans. Phys.-Tech. Lab.* [Leningrad], No. 5, pp. 52–71 (1928).—Breakdown of dielectrics by means of electric fields at a high temperature is explained by the heat theory. Difference of potentials when applied to a dielectric generates within the latter an electric current followed by the appearance of Joule's heat. If a dielectric is heated, the electric conductivity increases and with it the current flowing through the specimen increases. This is accompanied by a larger quantity of heat generated leading to the increase in temperature. If, however, a dielectric is well cooled from outside and the difference of potentials applied

is not very large, a stationary state is reached when the Joule's heat is completely absorbed by the outside medium. (*C.A.*)

Breakdown of glass in constant and alternating fields. A. F. WALTHER AND L. D. INGE. *Trans. Phys.-Tech. Lab.* [Leningrad], No. 5, pp. 20–39 (1928).—The influence of polarization on the breakdown of solid dielectrics is discussed. The effect of polarization at a high temperature is altogether negligible, while at a low temperature it becomes of predominant importance. This is shown by the fact that the breakdown of a specimen of glass takes place considerably later in the constant field than in alternating. (*C.A.*)

Breakdown of solid insulators. P. KOBEKO, I. KURCHATOV, AND K. SINELNIKOV. *Trans. Phys.-Tech. Lab.* [Leningrad], No. 5, pp. 5–19 (1928).—Breakdown of a series of dielectrics was studied with the conclusion that the decrease in the breakdown gradient with the decrease in the thickness of specimen layer is due to the change in the uniformity of the electrical field. When the field is made uniform a perfect proportionality for all dielectrics was obtained. In the investigation of the fatigue of dielectrics all specimens were divided into solid and plastic. In the solid dielectrics it was found possible to protect the breakdown gradient from the influence of the electrical field by eliminating corona effect. In the plastic dielectrics, within which rearrangement of particles constantly takes place, the destruction of the specimen is unavoidable, as the above particles possess different dielectric constants and different conductivities. (*C.A.*)

Breakdown of solid dielectrics at high frequencies. A. F. WALTHER AND L. D. INGE. *Zhur. Prikladnoi-Fiziki*, **5** [Suppl.], 47–65 (1929); Published in *Trans. State Phys.-Tech. Lab.* [Moscow], No. 8 (1929).—It is desired to trace the nature of the breakdown of dielectrics at radio frequencies and to determine whether the phenomenon may be accounted for by the thermal and ionization processes which constitute the breakdown at low frequencies. The experiment shows that on eliminating all disfiguring effects, the chief of which is the high-frequency corona discharge, it is possible to divide all dielectrics into 2 distinctly differing groups with regard to their behavior. It is peculiar to the dielectrics of the first group, among which glass is typical, that their breakdown tensions are strongly influenced by the temperature and frequency as well as by the conditions of the thermal conduction. Here the breakdown is of a thermal nature. At radio frequencies the dielectric strength of this group is much inferior to that exhibited at low frequencies. With the second group of dielectrics, *i.e.*, that of mica, the breakdown tensions are approximately equal in both cases. They do not depend on the temperature, on the frequency, or on the conditions of the thermal conduction. At high frequencies, the nature of the breakdown of dielectrics belonging to this group appears to be similar to that observed at low frequencies, *i.e.*, it should be associated with ionization. (*C.A.*)

Breakdown of solid dielectrics. A. F. WALTHER AND L. D. INGE. *Zhur. Prikladnoi-Fiziki*, **5** [3–4], 65–85; Published in *Trans. State Phys.-Tech. Lab.* [Moscow], No. 6, (1928).—It is established that the breakdown of some dielectrics at high temperature is of a purely thermal nature. All inferences of thermal theory of puncturing have received a complete corroboration. On the other hand, at low temperature this theory, as is known, does not hold good. The question is of considerable interest as to what is the nature of the puncturing in this instance. The present work shows that a considerable part of empirical inferences may be theoretically interpreted if, besides the thermal breakdown, a new conception of sheerly electrical (ionic) puncturing be introduced. In this case great importance should be attached to the local heterogeneities of an electric field at different points since they materially affect the dielectric strength. Besides, these heterogeneities render the puncturing dependent upon a series of fac-

tors, *e.g.*, frequency, etc. Results at all reliable and simple are obtainable only when measurements are conducted in a uniform electric field. (*C.A.*)

Fine porcelain industry in Manchuria. ANON. *Pottery Gaz.*, **55** [641], 1745 (1930).—The fine porcelain industry has only recently found a firm footing in Manchuria. The hitherto only important factory, which cost $1,200,000 about three years ago, employs about 400 hands, including 150 learners. The factory is mechanically equipped throughout. The present monthly capacity is about 600,000 pieces of tableware. In quality, the goods can compete with the corresponding Japanese products. E.J.V.

PATENTS

Manufacturing insulators. WILLIAM F. HARVEY. U. S. 1,779,811, Oct. 28, 1930. The method of making a one-piece insulator consisting in forming a multiplicity of skirts or lateral flanges by successive pressure operations on a wet mass of material, the pressure being applied endwise of the insulator and crosswise of the skirts.

Jugs, teapots, etc. BULPITT & SONS, LTD., AND W. H. BULPITT. Brit. 334,102, Oct. 15, 1930. The inwardly and upwardly inclined mouth portion surrounding the filling opening of a hot-water jug, teapot, etc., is provided with one or more pourer openings in place of the usual spout. The openings may be of triangular form and may be provided with overhanging hood portions formed by pressing upwardly the material displaced in piercing them. The openings may be covered by a peripheral flange projecting from the lid which closes the filling opening. The flange may have one or more cut-away portions adapted to register with the openings.

Equipment and Apparatus

Continuous-reading automatic viscometer. H. S. K. KOMHEIM. *Motive Power*, **1** [4], 33 (1930).—A direct-reading viscometer which automatically controls flow of fluid to constant speed through a calibrated friction tube is described. Sketches show a sectional drawing of instrument and diagrammatic hook-up of device to engine. (*C.A.*)

Device for addition of electrolytes to clays. G. A. BOLE. *O.S.U. Eng. Expt. Sta. News*, **2** [5], 2 (1930).—A pump made by the Manufacturing Engineers, Inc., Delaware, Ohio, and designed to acidify the water fed to pug mills in brick and tile plants in order to reduce drier and kiln losses will also proportion barium solution and pug water to prevent scum. The stroke is adjustable to feed up to 2%. Mixing takes place after water and acid both leave the pump and corrosive action is thus avoided. W.C.O.W.

Portable combustion test set. DEFENDER AUTOMATIC REGULATOR CO. *Gas Age-Rec.*, **66** [17], 705 (1930).—A new portable combustion test set for quick measurement of flue-gas temperatures (furnace or stack draft) and CO_2 percentages, weighing 10 lbs. in a carrying case is described in detail. Illustrated. E.J.V.

Combustion mixtures controlled automatically by valve. AUTOMATIC TEMPERATURE CONTROL CO. *Gas Age-Rec.*, **66** [16], 650 (1930).—Large valves for the close regulation of liquids and gases under a wide range of temperature and pressure conditions require a strong and sturdy motor-operated control mechanism to operate them in a satisfactory manner. The motor-operated three-position controller will develop a 200 lb. pull on the valve lever. This unit is mounted with a typical balanced V-port regulating valve for steam, water, oil, etc. The motor used is a series wound universal type for a.c. or d.c. and can be furnished for either 110 or 220 volts. The motor runs only when electrical contact is made, operating the lever arm through a crank a definite adjustable distance. Illustrated. E.J.V.

Instruments in the modern power plant. II. H. M. HAMMOND. *Eng. & Finance*, **21** [5], 254–59 (1929).—H. presents detailed sketches and descriptions of flow- and fluid-meters of different types and makes. **III.** *Ibid.*, **21** [6], 303–305 (1930).—H. discusses fluid meters and their use in measuring condensate, boiler feedwater, and drainage. **IV.** *Ibid.*, **22** [1], 9–11 (1930). **V.** *Ibid.*, **22** [2], 43–44 (1930).—H. discusses installations of automatic control instruments. For Part I see *Ceram. Abs.*, **9** [3], 215 (1930). R.G.M.

Analysis of mechanical methods of dust collection. M. A. LISSMAN. *Chem. Met. Eng.*, **37** [10], 630–34 (1930).—Methods used in the separation of solids carried in suspension by industrial gases are (1) the charged particles are carried across the gas stream by gravity, radial acceleration, or an electric field (settling chambers, cyclones, and electric precipitators); and (2) the solids adhere to surfaces located in the gas stream as in baffled settling chambers. The theory of removal of particles by gravity from a gas stream is discussed. An equation shows that the uniform velocity at which small particles fall in a settling chamber varies directly as the square of the radius and the density of the particle, and inversely as the viscosity of the gas. A table gives the rate of fall of spherical particles of unit density through air at 212°F. Discrepancies in results actually achieved in large settling flues are due to the impossibility of obtaining absolute rectilinear stream-line flow with large bodies of gases. Failure of the large settling flue can be ascribed to a "major turbulence factor," a complex function of the temperature differences in the gas stream, and of poor velocity and pressure distribution due to numerous causes. In centrifugal separators (cyclones and multiclones) use is made of radial acceleration to effect separation of particles suspended in the gas stream. The gas is forced into a spiral with an outer and inner vortex, virtually a fan with reversed gas flow. A derivation of the draft loss in a cyclone is given. Its chief advantage is in showing the effect of the several variables upon the draft loss, *e.g.*, varying the proportions of the cyclone. For the same entering velocity in similar apparatus, the draft loss is independent of the size of apparatus, but depends upon the ratio of radii of the inner and outer vortices. A table shows the variation of separation factors with an initial velocity of 60 ft. per second in the outer vortex. Several factors which affect the operation of large cyclones adversely are qualitatively discussed. They are (1) travel of particles, (2) major turbulence factor, and (3) rotational stiffness. In order to use the advantages of the small cyclone and yet handle large gas volumes, it is necessary to use a large number of cyclones in parallel. In the inner vortex, the separation factor is very large. Actual tests have shown a collection efficiency of over 99% where the diameter of the average particle was about 5 microns. G.R.S.

Removal of solids from gases. F. T. LEILICH. *Eng. & Finance*, **21** [5], 251–54 (1929).—L. describes the dry, wet, and electrical methods of separation of solids from gases, and cites instances of their use. R.G.M.

Tube mill without air-separation. ANON. *Tonind.-Ztg.*, **54** [80], 1278–80 (1930).—The description of tests on grinding lignite coke in a new tube mill without air-separation made by G. Polysius Company, Dessau, are given with tabulated results. M.V.K.

Modern grinding plant. ANON. *Brick Clay Rec.*, **77** [10], 533–41 (1930).—The West Darlington Clay Co. is described in detail as to equipment and process used. The clay being processed is of the Lower Kittanning vein and consists of two clays having slightly different physical properties which are enumerated. Illustrated. E.J.V.

Grinding cement clinker. A. C. DAVIS. *Cement & Cement Mfg.*, **3**, 1184 (1930).—Various types of equipment available for crushing and grinding cement clinker are described. Closed-circuit grinding increases the output of the mill unit as much as 10

to 20%, but the open-circuit grinding results in further reduction of the particles after the sieving classification conditions have been met, *i.e.*, it gives a lower average particle dimension. This grading of the fines with smaller particle dimensions gives the product of open-circuit grinding a cementitious value not yet obtainable in closed-circuit grinding. W.L.

Optical determination of high metallurgical temperatures. Melting point of iron. C. H. M. JENKINS AND MARIE L. V. GAYLER. *Proc. Roy. Soc.* [London], **129***A*, [809], 91–114 (1930).—The paper describes the adaptation of the optical pyrometer to the determination of melting, freezing, and transformation temperatures in metals and alloys by observation of a "black body" enclosure immersed in the metal. G.R.S.

Differential thermostat for use in calorimetry. S. WITHYCOMBE. *Gas Jour.*, **189** [3482], 378–79 (1930).—The differential air-water thermostat was designed to keep the temperature of water at not more than 5°C below room temperature. Water at this temperature is used in obtaining the calorific value of gas. A diagram shows the arrangement of the gas governor which is adjusted so that the heater comes into action as soon as the water temperature falls to 5°C below that of the air. A diagram shows the arrangement of steam-heated water supply. G.R.S.

New Brown indicating pyrometer controller. BROWN INSTRUMENT CO. *Brick Clay Rec.*, **77** [9], 498–99 (1930); *Clay-Worker*, **94** [4], 258 (1930).—A new Brown Model 801 indicating pyrometer controller can be supplied as an automatic control pyrometer, resistance thermometer, tachometer, or CO_2 meter. Ten outstanding advantages of this instrument are enumerated. E.J.V.

High-sensitivity absolute-humidity recorder. C. Z. ROSECRANS. *Ind. Eng. Chem., Anal. Ed.*, **2** [2], 129–34 (1930).—An apparatus is described which was developed for measuring and recording the amount of water vapor in the air, and which is suitable for recording humidities from zero up to saturation within a temperature range from −100 to about 200°C. From 0 to 10% at 25°C its accuracy is 0.05% relative humidity. This apparatus is based on the measurement of thermal conductivity of water vapor and air mixtures, and is continuous reading. A commercial modification of this apparatus is in successful operation although it is not yet perfected for general plant use. R.G.M.

Preparation of air of known humidity and its application to calibration of absolute-humidity recorder. A. C. WALKER AND E. J. ERNST, JR. *Ind. Eng. Chem., Anal. Ed.*, **2** [2], 134–38 (1930).—An apparatus is described whereby constant flowing mixtures of air and water vapor may be prepared, in which the moisture content varies not more than 0.001% by volume over long periods. This apparatus has been utilized to calibrate a sensitive humidity recorder capable of continuously recording atmospheric humidities up to 2.9% by volume of water vapor in air (equivalent to about 95% relative humidity at 25°C) with a sensitivity of 0.0016% by volume (0.05% relative humidity at 25°C). The use of the recorder in connection with the constant humidity apparatus is described and certain typical data illustrating the performance are given. R.G.M.

Double-pole double-throw mercury switch. G. H. DAMON. *Jour. Phys. Chem.*, **34** [11], 2627–28 (1930).—The use of a mercury switch eliminates to a large degree the variation in electrical-contact resistance. A diagram shows the electric wiring of the switch. The body is made of an insulating material such as bakelite, the contacting chambers being either molded or drilled in the insulating material. The central portion of each contacting chamber is depressed from the horizontal so as to provide a neutral or no contact position when the switch proper is parallel with its base. The main part of the switch is balanced on an axis which can be readily turned by a knurled knob. G.R.S.

Disk type pulverizer. ANON. *Chem. Met. Eng.*, **37** [10], 644 (1930).—The new MAG pulverizer is made by the Maschinenfabrik A.-G. of Geislingensteige, Germany. It is of the type in which a rotating disk carrying blades operates in conjunction with a stationary element also carrying numerous blades between which the material is crushed. It is designed for soft and medium-hard materials and is said to have a capacity greater than other machines of equal size. Dust-collecting and ventilating equipment for use with it are available. G.R.S.

Final report of the I.M.M. representatives on the sieves and screen committee of the British Engineering Standards Association. ANON. *Bull. Inst. Mining Met.*, No. 311, 9 pp. (1930).—The sieves proposed by the committee are divided in 3 series: fine, medium, and coarse. The fine series is based on the mm. and upon a ratio of $\sqrt[4]{2}$ between linear aperture measurements of consecutive sieves. For all practical purposes the American and British sieves are identical as to apertures, but not in respect to mesh, *i.e.*, the number of holes per linear inch. This difference arises from the use of wires of British S.W.G. Thus, the corresponding meshes of American and British standards are, respectively, 230, 240; 200, 200; 170, 170; 140, 150; 120, 120; 100, 100; 80, 85; 70, 72; 60, 60; 50, 52; 45, 44; 40, 36; 35, 30; 30, 25; 25, 22; 20, 18; 18, 16; 16, 14; 14, 12; 12, 10; 10, 8; 8, 7; 7, 6; 6, 5. The medium sieves (woven-wire cloth) are $^1/_{32}$, $^1/_{16}$, $^1/_8$, $^3/_{16}$, $^1/_4$, $^3/_8$, and $^1/_2$ inch. The coarse sieves (perforated metal plate) progress by $^1/_8$ in. increments from $^1/_2$ to 2 inch. The I.M.M. representatives present an amplified I.M.M. series in which the sieve number is the reciprocal of the theoretical size of aperture in inches, which they feel is superior. (*C.A.*)

Simple laboratory sieving machine. E. F. GRIEG AND L. SLATER. *Fuel Sci. Practice*, **9** [7], 338–40 (1930).—The authors describe a mechanical sieving device which will operate on samples from 5-mesh downward. The charge used is about 300 g. Two photographs of the machine are given and details of construction are presented. R.G.M.

New type vibrating screen. WILLIAMS PATENT CRUSHER AND PULVERIZER CO. *Brick Clay Rec.*, **77** [10], 558 (1930).—A vibrating screen known as "Kam-Tap" is suspended from a cam roller. One of its features is the unusually wide degree to which vibration can be regulated, as cams with four to eight points are available and interchangeable. E.J.V.

New diaphragm-motor valve. NEILAN CO., LTD. *Gas Age-Rec.*, **66** [15], 612 (1930).—A distinctly new type of improved rotary stem motor valve has just been perfected. This new valve was developed especially for high temperatures and pressures required in modern industrial processes. It is fully ball-bearing in construction, utilizing stainless-steel balls throughout the valve body where corrosive fluids are frequently present. The outstanding feature is the ease with which it can be kept packed tight even at high pressures. Illustrated. E.J.V.

New power scoop. CLARK TRUCTRACTOR CO. *Clay-Worker*, **94** [4], 249 (1930); for abstract see *Ceram. Abs.*, **9** [12], 1075 (1930). E.J.V.

Feeders and speed reducers. ANON. *Brick Clay Rec.*, **77** [10], 544–45 (1930).—Feeders are important links in the handling of raw materials, performing the dual rôle of conveyer and controller. Speed reducers have some interesting applications. Illustrated. E.J.V.

Use of tractors. ANON. *Brick Clay Rec.*, **77** [9], 486–87 (1930).—The versatility of the tractor as a piece of equipment for a clay-products plant is illustrated by photographs which portray it in various uses from furnishing power to a pit pump to the gathering of clay, etc. E.J.V.

Heavy-duty loader. ANON. *Chem. Met. Eng.*, **37** [10], 644 (1930).—Stephens-Adamson Mfg. Co. announces a new heavy-duty box car loader for bulk materials such

as stone. It uses a 30-in. belt with a speed of 2000 ft. per min. It has a capacity of 300 T. per hr. using a 7½-h.p. motor and 400 T. per hour with a 10-h.p. motor, and yet it can be handled by one man. The maximum lump size is 6 in. and the average trajectory height, 9 ft. Features of the machine include anti-friction bearings of dust-proof construction, and high-pressure lubrication. G.R.S.

Heat economy in steam brick plant. E. HÜTTEMANN. *Tonind.-Ztg.*, **54** [84], 1327–30; [85], 1345–47 (1930).—A steam brick plant usually has three sources of heat: (1) the steam power installation; (2) the firing kiln; and (3) additional heating for the drying installation. From all these sources, great quantities of heat are lost through the unused flue gases, radiation, conduction of heat from the boiler, machines and kiln walls, and in drying installations where only a part of the heat is used. Calculations and diagrams illustrate the article. M.V.K.

Laboratory muffle furnaces. H. WIMMER. *Chem.-Ztg.*, **54**, 184 (1930).—The advantages of a muffle heated by gas on the surface-combustion principle over the usual gas and electric muffle are enumerated. Rapid heating to 1500° and a high efficiency are claimed but no details of the construction are given. (*C.A.*)

Rotary furnace combines unique features. GEORGE J. HAGAN CO. *Gas Age-Rec.*, **66** [15], 612 (1930).—The most up-to-date developments in full automatic gas-fired rotary hearth furnaces are embodied in this new equipment. Some of the outstanding features of the furnace are described in detail. Illustrated. E.J.V.

Supermal: superior wear-resisting metal for chains and buckets. JEFFREY MANUFACTURING CO. *Brick Clay Rec.*, **77** [10], 558 (1930).—Supermal embodies greater resistance to wear, higher tensile strength, and a higher elastic limit than heretofore developed in malleable iron. It is "file hard," tough, and ductile. Comparisons of the characteristics with malleable iron, soft cast steel annealed, and manganese steel are presented. Illustrated. E.J.V.

BOOKLET

Promal Chains. LINK-BELT CO. Booklet No. 1050. Reviewed in *Clay-Worker*, **94** [4], 258 (1930); see also *Ceram. Abs.*, **9** [11], 958 (1930). E.J.V.

PATENTS

Feeding mechanism for presses. RAYMOND T. ANDERSON. U. S. 1,780,218, Nov. 4, 1930. In a press, the combination of a shell, means located therein for effecting pressure upon material to be pressed, a feed inlet, a chute in communication therewith, a spiral element formed from spring material located within the chute, and means for rotating the element.

Testing machine. ALFRED J. AMSLER. U. S. 1,780,696, Nov. 4, 1930. A testing machine of the type described, comprising in combination, a pendulum comprising a swingably-mounted arm and a weight carried by the arm and adapted to break a test piece by its impact when moving downward from a raised position of the arm, a vertical guide, a uniformly graduated scale adjustable along the guide, a circular member arranged on the arm so that the center of the member is situated on the line passing through the center of gravity of the weight and the turning axis of the pendulum, a horizontal straight edge rigidly fixed to the scale and coöperating with the member for adjusting the scale in height to correspond to the initial position of the pendulum, a further vertically-guided, horizontal straight edge acted upon by the member when the pendulum swings in the upward direction after the impact, a hand operatively connected to the latter straight edge and coöperating with the scale for indicating the vertical component of the upward movement and thereby the amount of energy spent in

the impact, and a rope brake connected to the pendulum and adapted to automatically brake the movement of the pendulum after it has attained its highest position following upon the impact.

Viscosimeter. ERNEST M. SYMMES. U. S. 1,780,952, Nov. 11, 1930. Apparatus for determining the viscosity of a fluid comprising a viscosimeter tube open for the reception of a fluid, a radio circuit including an oscillating radio tube having grid and plate filament circuits, the grid and plate filament circuits extending about the viscosimeter tube, means for detecting variation in the rate of oscillation of the radio tube, and means for limiting the field of the grid and plate filament circuits adjacent to the tube.

Disk feeder and mixer. LOUIS C. BONNOT. U. S. 1,781,097, Nov. 11, 1930. A disk feeder and mixer including a plurality of bins each adapted for containing a different material, a feeding disk mounted for rotation a substantial distance below the bins, a mixing disk mounted for rotation below the feeding disk, a spout extending between each bin and the feeding disk for discharging material from the bin onto the feeding disk, a scraper associated with each spout for scraping material discharged therefrom onto the mixing disk, and a scraper for mixing and scraping the material from the mixing disk.

Screening materials. MORLEY PUNSHON REYNOLDS. U. S. 1,781,526, Nov. 11, 1930. In apparatus of the character described, the combination of a stationary frame, a woven wire screen supported in an inclined position in the frame, the screen being engaged along two opposite edges in the frame and being tensioned to a uniform vibratory tension, a second woven wire screen of considerably finer mesh than the first-named screen supported upon the first-named screen in an untensioned condition, and means for rapidly vibrating the first-named screen.

Controlling flow of solid materials. HUMPHREYS AND GLASGOW, LTD. Brit. 329,110; *Colliery Guard.*, **141** [3641], 1365 (1930).—The controlling device consists of a series of heavy metal prongs of suitable hook-like shape, pivotally mounted on a shaft that is mounted in bearings in the side walls of the outlet chute from the hopper. Raising the prongs permits passage of material down the chute while lowering them stops it. E.J.V.

Spectrum analysis. A. HILGER, LTD., AND F. TWYMAN. Brit. 334,618, Oct. 29, 1930. The relative proportion of an element in a specimen is determined by comparing the intensity of a line corresponding thereto with that of a line corresponding to another element by means of apparatus in which spectrum parts are brought side by side and means are provided for relatively moving the spectrum parts so as to bring predetermined lines into juxtaposition for comparison. A tint wedge is mounted in the path of one of the spectra and may be rotated until the apparent intensities are equal. The calibration of the wedge gives the relative intensity of the spectra and the relative proportion of the elements. In a modification one part of the spectrum may be separated perpendicularly to the slit and the movable part of the spectrum adjusted between them so that widely separated lines may be compared with one another. The apparatus may be used with photographic, photoelectric, or thermal apparatus.

Rotary oven. KOHLENVEREDLUNG A.-G., Ger. 490,535; *Gas Age-Rec.*, **66** [17], 707 (1930).—This rotary oven is suitable for physical or chemical treatment of granular or dusty materials. The heating gases are led over the materials that are being treated in the same direction of flow as the movement of these materials. The latter are moved through the retort partly by mechanical devices. The oven is built in such a manner that its cross-sectional area gradually decreases. The flow of gases through the oven to heat the materials therein serves also to convey the materials through it. E.J.V.

Kilns, Furnaces, Fuels, and Combustion

Flow method for comparing specific heats of gases. I. Experimental method. P. M. S. BLACKETT, P. S. H. HENRY, AND E. K. RIDEAL. *Proc. Roy. Soc.* [London], **126A** [801], 319–32 (1930).—The method consists in passing a slow stream of gas through a narrow tube along which a temperature gradient has been established. The change of the temperature distribution along the tube depends on the properties of the gas and the rate of flow. It was found possible to choose the arrangement so that the measured difference between two parts of the tube was a direct measure of the specific heat of the gas flowing in the tube. The temperature of the gas was not measured but that of the tube containing the gas was determined without in any way disturbing the flow. The method is described. An apparatus was devised which has given results confirming the theoretical equations. **II. Theory of the method.** *Ibid.*, **126A** [801], 333–54 (1930).—The heat, H, conducted from the unit length of the tube to the gas in unit time was obtained from the equation

$$H = Q\frac{d\Theta}{dz} + \frac{11}{48\pi}\frac{Q^2}{R}\left[\frac{s+s'+1}{T}\left(\frac{d\Theta}{dz}\right)^2 - \frac{d^2\Theta}{dz^2}\right]$$

in which Q = the quantity of gas flowing through the tube, Θ = the temperature of the tube, z = length of gas cylinder, R = the conductivity of the gas, T = absolute temperature of the walls of the tube, and $\frac{d\Theta}{dz}$ = the variation of temperature with the length of the tube. The theory is applied to a symmetrical electrically-heated tube. The good agreement between theory and experiment lends strong support for the validity of the above equation. G.R.S.

Wind pressure on chimneys. ANON. Bur. Stand., *Tech. News Bull.*, No. 160, p. 77 (1930).—One of the major elements determining the cost of a large chimney or stack is the amount of wind pressure it is to withstand. In many instances the values used by bidders for constructing stacks are too high thus increasing the cost without corresponding benefit. For several years an investigation of the wind pressure on chimneys and other cylindrical structures has been in progress at the Bureau. The investigation showed that the wind pressure is a function of the ratio of the height of the chimney to its diameter and that a wind pressure corresponding to 20 lbs./sq. ft. of projected area at a wind speed of 100 m.p.h. is a safe value to use in designing chimneys of which the exposed height does not exceed 10 times the diameter. R.A.H.

Rationalized gas annular kiln and drying installation. FRANZ RAULS. *Sprechsaal*, **63** [40], 758–59 (1930).—A new drying installation which has been annexed to a gas-heated annular kiln is described. Greater use is made of the heat, and economy of space and operating costs is obtained. Diagrams show the arrangement of the chambers. M.V.K.

Management of gas producers. L. M. WILSON. *Fuel Sci. Practice*, **9** [4], 152–64 (1930).—W. describes the management of a producer plant in practice, considering in detail some of the general factors and problems involved in producer-gas installations without respect to any one particular design of machine. R.G.M.

Dehydration of manufactured gas. F. W. SPERR. *Fuel Sci. Practice*, **9** [6], 266–81 (1930).—S. describes the principal methods available for the dehydration of manufactured gas in order to prevent corrosion of mains, pipes, meters, and appliances. R.G.M.

Gas producers. C. MIEDBRODT. *Gas Age-Rec.*, **66** [17], 707 (1930); for abstract see *Ceram. Abs.*, **9** [12], 1089 (1930). E.J.V.

Controlling equipment for gas-heating appliances. W. E. STARK. *Gas Age-Rec.*, **66** [15], 598–602 (1930).—Controlling equipment for gas-burning appliances falls into

three classes: gas operated, mechanically operated, and electrically operated. Devices which fall into these various classes are described in detail. Illustrated. E.J.V.

New lever-type gas valve. TIME-O-STAT CONTROLS CO. *Gas Age-Rec.*, **66** [17], 705 (1930).—A new $^3/_4$ in. electric lever-type gas valve, specially designed for use with space heaters, unit heaters, and conversion burners is announced. This valve, known as the No. 606 electric gas valve, is designed to pass a large amount of gas with a minimum pressure drop and will operate on gas pressures up to 1 lb. Illustrated. E.J.V.

New underfeed stoker. MARION MACHINE, FOUNDRY & SUPPLY CO. *Clay-Worker*, **94** [4], 251 (1930).—A new underfeed stoker known as type "U," intended for use in steam power plants with boiler ratings up to 200 h.p., has recently been perfected. The component parts consist of retort, tuyères, dump grates, conveyer screw, hopper, transmission, fan motor, machinery casing, and control. A detailed description of the operation and construction of the stoker is given. E.J.V.

Factors to consider when using natural gas. CHARLES F. BUTZ. *Brick Clay Rec.*, **77** [10], 529–30 (1930).—Four interesting points of information in consideration of natural gas are (1) its composition, (2) amount of air required to burn natural gas, (3) flue gases resulting from combustion, and (4) rate of flame propagation. Each of these points is explained in detail. The economy with which natural gas can be burned depends upon the burner, the fireman, and the kiln. Burners in which both the gas and air are separately controlled give better results because with them it is possible to secure the most effective type of flame. A comparison of the fuel consumption between various fuels shows that 150 to 160 cu. ft. of 840 B.t.u. gas are equivalent to one gallon of oil, and 23,000 cu. ft. are equivalent to one ton of 12,500 B.t.u. coal. Results of installing natural gas on kilns for firing silica ware are given. Illustrated. E.J.V.

Natural gas. ANON. *Brick Clay Rec.*, **77** [10], 528–29 (1930).—Natural gas is by no means a new fuel insofar as the firing of clay products is concerned, having been successfully used in the East and Southwest in firing grays and buffs. It is susceptible to close temperature control and burns with a clean, oxidizing flame. New problems and new considerations are introduced in considering natural gas as a fuel for such products as common brick, red and buff flashed brick, sewerpipe, fire brick, etc. Under these conditions it becomes largely a question of the economy of natural gas over other fuels and its ability to flash successfully. Another consideration is the fact that the flame or products of combustion of natural gas are not naturally radiant, *i.e.*, little heat will be imparted to the ware through direct radiation from the flame as is the case with coal flames. Fuel costs are naturally subject to a great many variables, and a further charge would be the difference in the cost of firing equipment. E.J.V.

Natural gas, an economical fuel. ANON. *Clay-Worker*, **94** [4], 240–43 (1930).—The Bostonia Coal and Clay Products Co., New Bethlehem, Pa., has been firing its products for a number of years with natural gas from their own wells producing a product of good color and strength. A detailed description of the plant equipment and methods used is given. Illustrated. E.J.V.

Natural gas practice. ANON. *Brick Clay Rec.*, **77** [10], 531–32 (1930).—A detailed description of the natural gas installation used for firing both red and buff face brick and flashing successfully with zinc at the Hill Brick Co., East St. Louis, Ill., is given. Data on natural gas practice and installations in about four other clay products plants are presented. Illustrated. E.J.V.

Turbulence and inflammability of natural gas. ANON. *Engineering*, **130** [3377], 439 (1930). A.A.

Coal cleaning in modern times. R. LESSING. *Gas Jour.*, **189** [3478], 147–50 (1930).—Impurities in coal make themselves felt in the coke and also have certain

influences on the quality and quantity of gas made. The bulk of ash comes from materials which are not in the coal itself. These ash-forming materials are of two classes, shale and pyrites (including calcium and iron carbonates). True coal substance can be classed in four different groups, the coking portion, (1) vitrain and (2) clarain, the bright, lustrous portion of the coal, (3) durain, feebly-coking substance, and (4) fusain, a charcoal-like powder of very friable material, interspersed in the coal seam in very thin sheets or veins. It is the only substance in coal which soils the fingers, and does not exceed 5% in most coals. The ash of fusain often makes up 12 or 15% of this material, and is composed of calcium and iron carbonates. The other constituent of high ash is shale, which averages 75%. Large lumps of coal are comparatively pure. The float and sink test determines the efficiency of ordinary coal washing. The sample of coal is put into a bath of a liquid whose specific gravity lies between that of the coal and the shale. The only commercial way in which coal can be cleaned down to its inherent coal content is first by dedusting and secondly by gravity separation of the dedusted coal from the shale and pyrites. A description is given, illustrated with diagrams and photographs of a plant in South Wales where this process is carried out.
G.R.S.

Pneumatic coal-cleaning plant at Horden. ANON. *Engineering*, **130** [3376], 390–92 (1930).—The coal-cleaning plant of the Horden Collieries, Ltd., at Darlington, which is the largest plant of this type in Europe, with a capacity to clean 250 T. of coal below $2^1/_4$ in. in size per hour is described and illustrated. A.A.

Modern ideas on coal. F. V. TIDESWELL. *Fuel Sci. Practice*, **9** [7], 296–306 (1930).—T. discusses the fundamental studies on coal. Charts of compositions are presented. R.G.M.

Sampling and analysis of coal for inland use. BRITISH ENGINEERING STANDARDS ASSN. *Colliery Guard.*, **141** [3642], 1418–22 (1930).—Excerpts of a detailed draft specification for the sampling and analysis of coal for inland purposes are presented for study and criticism. E.J.V.

Research on pulverized fuel burners. ANON. *Colliery Guard.*, **141** [3641], 1317–18 (1930).—The pulverized fuel plant installed at the Fuel Research Station (England) consists, first, of apparatus of a purely experimental nature, and secondly, of more or less standard equipment. The first group is employed mainly to explore the scientific principles involved in the combustion of powdered fuel in small spaces, and also to test short-flame burners qualitatively without actually fitting them into a boiler. The main difficulty in burning powdered fuel lies in obtaining contact between the minute coal particles and the oxygen required for their combustion. The Vortex combustion chamber departs from most burners or combustion chambers by making use of streamline motion and by attempting to control the relative movement of the fuel and air. The effect aimed at is equivalent to having a stationary bed of fuel through which air passes. The method employed is to cause the air for combustion to take up a spiral vortex motion from the circumference to the center of a cylindrical combustion chamber into which the fuel is introduced in pulverized form. The results obtained with this chamber appear to be in good agreement with those predicted from theoretical considerations. Another combustion chamber tested was the impinging jet combustion chamber, suggested by Stanton, and this was found to be approaching the ideal for use with a Lancashire or marine boiler. The grid burner supplies the primary air and fuel through a number of narrow slots so as to form a number of thin parallel sheets of fuel and air, introducing between them similar thin sheets of preheated air. Illustrated. E.J.V.

Reactivity of carbon materials. Y. OSHIMA AND Y. FUKUDA. *Fuel Sci. Practice*, **9** [5], 200–12 (1930). R.G.M.

Artificial atmospheres for electric furnaces. II. A. N. OTIS. *Iron Age*, **126** [13], 844–48 (1930).—Preventing oxidation through use of an atmosphere rich in hydrogen, and preventing decarburization by small methane content are functions of a controlled atmosphere in a furnace. Apparatus and methods are described. For Part I see *Ceram. Abs.*, **9** [12], 1079 (1930). E.C.C.

Stoker-fired periodic kilns. ANON. *Brick Clay Rec.*, **77** [9], 473 (1930).—While stoker-fired periodic kilns have long been the ambition of clay-products manufacturers no definite progress toward the adaptation of stokers for periodic-kiln firing was made until the problem was taken up for study at the Roseville (Ohio) Experimental Brick Plant in coöperation with the Whiting Corp. who furnished, for experimental purposes, a Whiting "King Coal" mechanical stoker. Results being obtained now seem to show that the stoker idea is a wholly practical one for firing periodic kilns and offers the opportunity for material reductions in fuel cost and in increase in quality. Details of two kiln set-ups used are given. The differences in design of the two kilns and the advantages of the second over the first are pointed out. Data on stoker operation are presented. Illustrated. E.J.V.

Apply Hoffman principles to tunnel kiln. WILLIAM A. BUTLER. *Brick Clay Rec.*, **77** [9], 481 (1930).—The railroad tunnel kiln, like all other continuous brick firing systems, is a modification of the original continuous kiln first introduced to German brickmakers in 1855 by Frederick Hoffman. There are two principal points of economy in the Hoffman kiln just as there are two different conditions of draft. A part of the economy, which appears to be less than one-half, is obtained by the high-temperature gases carried by the draft from the burning brick, passing through green brick set in advance of the full fire. Where the greatest economy of the Hoffman kiln exists, and which economy has never been equaled by any brick-firing system, is in that portion back of the "neutral zone" in which the air of combustion moves through the already fired, incandescent brick. Details of construction for a tunnel kiln which will be designed from the Hoffman kiln and embody the economic features of it are given. E.J.V.

Device for removing deposits in a rotary kiln. SCHEID. *Tonind.-Ztg.*, **54** [84], 1332 (1930).—Chemical reactions between the refractory coating of the rotary kiln and the fuel occur during firing and cause the formation of deposits in the hottest parts of the kiln. These deposits are very difficult to remove. A new device, the "Loesche-Kanone," which has recently been invented removes the deposits easily. It works on the same principle as the "cement-gun" used in the U.S., but is improved. M.V.K.

Heat consumption and distribution in one-chamber kilns. JOSEF ROBITSCHEK. *Sprechsaal*, **63** [19], 345–47; [20], 361–63 (1930); *Refrac. Jour.*, **5** [60], 460 (1930).—R. discusses and criticizes the work of Carl Loeser (see *Ceram. Abs.*, **8** [7], 524 (1929)) on heat requirements, distribution, and balances in ceramic chamber kilns. The researches of other investigators and their works on this question are cited. Tables illustrate the article. M.V.K.

Kiln of Groum-Grjimailo. G. SHTUIKGOLTZ. *Bldg. Materials*, No. 1, 5 pp. (1930).—A description of a new kiln for firing brick is given and compared to the Hoffman kiln. The kiln is a rational annular kiln constructed on the hydraulic theory of the movement of gases. A system of intersecting tubes gives a correct motion to the gases and guarantees uniform heating and cooling of fired brick; in this way the great defect of the Hoffman kiln is avoided. M.V.K.

"Carboradiant" kiln. ANON. *Clay-Worker*, **94** [4], 250 (1930).—The construction and operating details of the kiln are discussed. See also *Ceram. Abs.*, **9** [8], 663 (1930). E.J.V.

Heat transfer through metal-inclosed insulation. M. S. VAN DUSEN. Bur. Stand.,

Jour. Research, **5** [2], 385–97 (1930).—The paper gives a mathematical treatment of the problem of heat transfer through an insulated metal-inclosed panel, such as a sheet-metal door, consisting essentially of a sheet-metal box filled with insulating material. The treatment is necessarily approximate, but the approximations involved are accurate enough for practical purposes. The effect of a solid metal thermal short circuit, such as a supporting member extending from one metal surface to the other is also considered. Calculations and graphs are included, showing the relative magnitude of the heat transfer by metallic induction in a number of cases which might be considered in the design of this type of construction. It is shown that the increase in heat transfer through a metal-inclosed panel due to the presence of the metal may be as high as 100% in many cases which might be considered in practical design. R.A.H.

Insulating ceramic furnaces against earth moisture. O. KALLAUNER. *Repts. Czechoslo. Ceram. Soc.*, p. 23 (1928).—The insulation consists of 2 layers of earthenware brick, laid on their flat side, the gaps between being filled with mortar to a height of 2 cm. The remaining space is left empty by covering the brick layer with T-shaped sheets. R.B.

Ceramics and heat technology. GUSTAV KOPKA. *Repts. Czechoslo. Ceram. Soc.*, p. 24 (1924).—Two diagrams. R.B.

Chemical analysis of solid fuels. C. GOSSETTI. *Ind. del Cemento*, **26** [12], 110–12 (1929); *Tonind.-Ztg.*, **54** [79], 1272 (1930).—The Italian Research Institute has published standards for sampling and testing fuels. The determination of the water content is made on a 50-g. sample at 105 to 110° in a double-walled drying closet. This temperature is maintained by filling the hollow spaces with a mixture of 3 parts glycerine and 1 part distilled water. Drying for $1^1/_2$ hrs. is considered sufficient. Longer drying sometimes causes disintegration. Three g. coal are heated to redness at 850 to 900° for the determination of the ash content. If the ash contains disintegrating ingredients, *e.g.*, carbonates, the temperature of heating to redness is only 600°. The volatile ingredients (coking samples 2 g.) are determined according to a method of Mucksh modified by Bochum. The change is brought about by the escape of gases through a hole of 2 mm. width in the lid of the crucible. The state of the coke must be noted exactly. The determinations of sulphur, according to the method of Eschke, and of the heat values are made according to known prescriptions. Small cylindrical testing bodies are made from the ash using a very small quantity of starch paste. They are heated in a kiln appropriate for determining the melting point of the ash. The temperature at which the edges of the cylinders begin to round is considered to be the beginning of the melting point. The temperature is determined either optically or with similarly shaped cylinders of Seger cone paste. Ashes of good coals begin to melt from 1300° on up. M.V.K.

Present position of the world's fuel. F. W. BURSTALL. *Gas Jour.*, **189** [3478], 159 (1930). G.R.S.

BOOKS

Economic Kilns for Common Brick and Tile. WILLARD RICHARDSON. Reviewed in *Clay-Worker*, **94** [4], 258 (1930).—This booklet deals with the different forms of the Hoffman type kiln, as used in the U.S., giving dimensions, draft, method of setting, firing, and advantages, and the Richardson continuous kiln, a near type of the Hoffman kiln, with all the Hoffman advantages and added features, *i.e.*, Richardson automatic stoker and Richardson preheated bottom and downdraft water-smoking system. Information relative to draft dampers, continuous kilns without crown, the zig-zag kiln, tandem compartment kiln, the Richardson kiln drying system, and car tunnel kiln is also given. E.J.V.

Drying of Coals. MAX WEISS. Reviewed in *Mining & Met.*, **11** [287], 10 (1930); for abstract see *Ceram. Abs.*, **9** [12], 1087 (1930). E.J.V.

Water Gas. J. GWOSDZ. Reviewed in *Mining & Met.*, **11** [287], 10 (1930); for abstract see *Ceram. Abs.*, **9** [12], 1088 (1930). E.J.V.

Gaseous Combustion at High Pressures. W. A. BONE, D. M. NEWITT, AND D. T. A. TOWNEND. *Gas Jour.*, **189** [3476], 34 (1930); see also *Ceram. Abs.*, **9** [9], 775 (1930). G.R.S.

Sources of Calorific Energy and Industrial Heating. EMILIO DAMOUR. Encyclopedia of Industrial Chemistry Series. C. Chabrié, Editor-in-Chief. Reviewed in *Gas Age-Rec.*, **66** [18], 735 (1930); see also *Ceram. Abs.*, **9** [12], 1088 (1930). E.J.V.

PATENTS

Tunnel kiln. OSCAR L. BARNEBEY AND MERRITT B. CHENEY. U. S. 1,778,747, Oct. 21, 1930. A tunnel kiln comprising a lower compartment having cooling means, and an upper compartment having adjustable supplies of heating, cooling, and reactive fluid distributed therein at the central portion and at points intermediate the central portion and each end of the kiln for positively regulating and controlling the temperature and the reaction at each stage of the kiln and producing gradual gradient of temperature from each end of the kiln to the central portion of highest temperature, means for atomizing water into the exit end of the upper compartment of the kiln and means for regulating the return to the kiln of the gases exiting therefrom.

Gaseous fuel-mixing device. GEORGE H. DAWES AND MAX C. LEWIS. U. S. 1,779,422, Oct. 28, 1930. In combination with the intake and exhaust manifolds of an internal combustion engine, a vaporizer for the fuel comprising an inlet conduit for the intake manifold including a portion passing through the exhaust manifold, the portion of the inlet conduit which is inclosed by the exhaust manifold being partially filled with short metallic tubular members providing tortuous passages for the air and gases through the inlet and means for retaining the members therein.

Tunnel kiln. ARTHUR MCDOUGALL DUCKHAM. U. S. 1,780,119, Oct. 28, 1930. In an annular tunnel kiln of the kind herein referred to, longitudinal flues arranged in the walls of the cooling zone of the kiln, and an exhaust duct in communication with the flues and with the waste gas flue, the flues having communication with the interior of the kiln chamber intermediately of the duct and the zone of open firing.

Gas burner. MASCHINENBAU A.-G. Ger. 490,540; *Gas Age-Rec.*, **66** [17], 707 (1930).—The gas and air openings are arranged around the circumference of a circle in this burner. These openings are placed so that the air and gas emerge from them tangentially and obliquely with respect to the axis of the burner. The venturi and combustion chambers in the burner are completely filled with the gas and air mixture. This burner can be used with compressed air and gas under pressure. E.J.V.

Indirectly-heated drying chamber for pottery. JULIAN RAKOVSKII. Ger. 503,005, Dec. 15, 1927. (*C.A.*)

Firing oven for ceramic goods. JOSEF THIEL. Ger. 503,327, April 5, 1929; see also *Ceram. Abs.*, **9** [6], 464 (1930). (*C.A.*)

Geology

Diatomaceous earth. I. W. HUGILL. *Colliery Guard.*, **141** [3641], 1356 (1930); *Pottery Gaz.*, **55** [641], 1757 (1930).—This part of the paper is concerned with the structure and properties of diatoms in heat-insulating materials. A general description is given of living and fossil diatoms, the siliceous shells of the latter forming the main bulk

of diatomaceous earth (diatomite, etc.). Some variations in the structure of the microscopic shells are illustrated. Some of the diatomaceous earths on the market are so finely broken up that they are unsuitable for making heat insulators. Others are unsuitable because diatoms do not constitute a sufficient proportion of the material. The influence of diatom structure on heat insulation is under investigaton and the possibility of applying the diatomaceous earth to other uses is being considered.

E.J.V.

Changes in hornblende at about 800°C. V. E. BARNES. *Amer. Mineralogist*, **15** [9], 393–417 (1930).—Green hornblende, when heated in air, changes to brown hornblende which has the same optical properties as basaltic hornblende. The iron-poor hornblendes do not change on heating. On heating, tremolite behaves like the iron-poor hornblendes and actinolite like the iron-containing hornblendes. The changes obtained in the iron-rich varieties are as follows: increase in (1) density, (2) indices of refraction, (3) birefringence, and (4) dispersion; decrease in extinction angle; and change in optic angle to about 65°, and in pleochroism and color from greens to browns. Brown hornblende when heated in hydrogen changes back to green. The conclusions are that (1) oxidation of ferrous to ferric iron causes the changes in optical properties observed upon heating common hornblende; (2) dehydration is of no importance except as it allows oxidation to proceed; (3) inversion is not present as proved by lack of change when heated in H_2; (4) in dehydration, hydrogen and not water (except water is not a constituent part of the space lattice) is given off, and the oxygen remains in the mineral, either oxidizing ferrous to ferric iron, or when ferrous iron is not present, remaining because of its size. G.R.S.

Action of hydrochloric acid and soda solution on potassium mica. E. PEREFETSCHINA. *Trans. Ceram. Research Inst.* [Moscow], **18,** 16–17 (1929); *Tonind.-Ztg.*, **54** [79], 1272 (1930).—From tests made by P. to determine the action of hydrochloric acid and soda solution on potassium mica the following conclusions can be made: (1) primary and secondary micas containing potassium are strongly affected by hydrochloric acid, but the secondary micas are less affected than the primary; (2) disintegration of a mica fired to 590° is greater than the disintegration of raw mica and a completely dehydrated mica is more affected; (3) the quantity of decomposed mica depends on the concentration of the acid; (4) changing the grain size changes the degree of disintegration of mica; (5) under different conditions of decomposition, the proportion of the dissolved constituents of mica remains constant. M.V.K.

Phenomena of kaolinization. FRANCESCO RAVELLI. *Chim. ind. agric. biol.*, **5,** 162–64 (1930).—The phenomena of atmospheric decomposition, pneumatolytic action, etc., in the formation of kaolin are discussed, with regard to the Italian (Tuscany) deposits, the most important in Europe. (*C.A.*)

Discolorations in fired kaolin. BERNHARD NEUMANN. *Sprechsaal*, **63** [40], 757–58 (1930).—Some brick made of a homogeneous paste of Zettlitz kaolin of high quality showed blue gray and sometimes brown reniform infiltrations and gray stripes in their interior after firing. These discolorations were of two kinds: (1) light gray blue, and (2) yellowish to brownish stripes which are often accompanied by gray to black bands. Investigations showed that the yellow brown stripes were caused by iron oxide and the gray discolorations by carbonic acid. The gray blue spots were caused by titanium oxide and appear only with reduced firing. The appearance of such liquations and enrichments of impurities in a thoroughly homogeneous slip of such a highly dispersed substance as kaolin, is not yet explained. M.V.K.

Influence of zinc oxide on the properties of Sedlec (Zettlitz) kaolin. O. KALLAUNER AND O. TYKAČ. *Repts. Czechoslo. Ceram. Soc.*, p. 46 (1928); for abstract see *Ceram. Abs.*, **9** [6], 443 (1930). R.B.

Industrial employment of bentonite. ANON. *Le Genie Civil; L'Industrie Chimique*, **17** [197], 407 (1930).—The properties and uses of bentonite and the emulsions formed are discussed. See also *Ceram. Abs.*, **9** [4], 305 (1930). (*S.S.*)

"Zonolite," a new industrial mineral. ANON. *Can. Chem. Met.*, **14** [10], 36 (1930).—"Zonolite" is the trade name given a commercial product manufactured from vermiculite by the simple process of dispersing its natural water content by means of applied heat. Vermiculite has a specific gravity of 2.3. Its composition is 41.0% silica, 7.0% iron oxide, 18.0% aluminium oxide, 21.0% magnesium oxide, 1.0% calcium oxide, 1.0% alkalis (sodium and potassium), and 11.0% moisture. In appearance and to touch, vermiculite is similar to crude mica of a dark green color. Heat treatment to drive off the moisture also causes an expansion so that the resultant product, known as "Zonolite," has a specific gravity of 0.16 to 0.32. The economic value of Zonolite is attributable to its thermal and sound-insulating properties, its ability to withstand high temperatures, its light weight, and pleasing appearance. Successful applications of Zonolite for industrial purposes include its use as high-temperature insulation in the construction of bake ovens and dry kilns, for pipe and boiler coverings, etc. See also *Ceram. Abs.*, **9** [7], 573 (1930). E.J.V.

Chromium ore resources of the world. H. CARLBORG. *Jernkontorets Annaler*, **113**, 1–24 (1929).—The chief sources of chromium ore in the world are enumerated, short descriptions being given of the principal mining districts. The deposits in southern Rhodesia are the most important and supply about 50% of the total production of the world. New Caledonia and British India follow yielding together 25% of the production, the remainder coming from Turkey, Asia, Canada, and other places. Ample supplies of chromite are assured for the immediate future. (*J.I.S.I.*)

Armenian pumice stone. S. OTAROFF. *Bldg. Materials*, No. 1, 2 pp. (1930).—The description and chemical composition of large deposits of pumice stone in Russian Armenia are given. The quality of this pumice stone makes it suitable for brick, pumice cement, and the preparation of green glass. M.V.K.

Canadian feldspar production increases. ANON. *Can. Chem. Met.*, **14** [10], 36 (1930).—Feldspar shipments during 1929 were 37,527 T., valued at $340,471, an increase of 17.6% in quantity and 19.5% in value over 1928 totals. The production in Quebec amounted to $133,492, and in Ontario, $206,979. Crude feldspar exports of 29,896 T. valued at $242,915 were made chiefly to the U.S. E.J.V.

Canadian production of crude and ground feldspar. GEORGE GREGG FULLER. *Commerce Repts.*, **42**, 170–71 (1930).—It has been announced that the Buckingham Co. is erecting a plant to have a capacity of 40,000 T. of crude feldspar. This capacity is five times domestic requirements. The output of the new plant will be exported. If exported to England this new supply of cheap feldspar for the English ceramic manufacturers may assist them to compete with American ceramic products in Canada and other foreign markets. E.J.V.

Saskatchewan clays of Dominion importance. W. G. WORCESTER. *Trans. Can. Inst. Mining Met.*, **32**, 255–69 (1929); for abstract see *Ceram. Abs.*, **8** [6], 441 (1929). (*C.A.*)

Kaolins and refractory clays in Italy. I. F. SAVELLY. *Corriere ceram.*, **11** [7], 299–303 (1930).—The chemical-geological phenomena bringing about the formation of kaolin deposits are given. The knowledge of these phenomena form the basis for the classification, and beneficiation of kaolin. All mineralogical, geological, optical, chemical, electrical, thermic, and metallurgical sciences contribute to the study of the preparation of a good kaolin. **II.** *Ibid.*, **11** [9], 355–61 (1930).—Clays can be considered as a mixture of colloidal, gelatinous masses with undecomposed crystalline particles. The colloidal substance in clay is probably composed of the gelatinous

silicate of alumina hydrate, organic colloidals, gelatinous silica, ferric hydroxide, and other substances in which crystallization has just begun. Experience shows that the greater the colloidal (organic and inorganic) content of a clay, the fatter and more plastic it is and the greater the loss on firing. Kaolins and clays are contrasted: kaolins are products of primitive formations of volcanic rocks, subsequently kaolinized in the same location by atmospheric, pneumatical, or pneumohydrolitic influences, or the action of carbonic or humic acids; clays are products of chemical decomposition and mechanical erosion of primitive rocks transported and deposited outside the zone of the original rock. The alkali and iron oxide content is greater in clays than in kaolins, which, on the other hand, have more water of combination. The alkalis of clays are dissolved in hydrochloric acid. Clays absorb only basic organic colors while kaolins react normally to basic, organic, and acid colors. There are many different kinds of clays and they are classified according to their use. Some of the characteristics common to all types are (1) friability, (2) characteristic color derived from organic constituents when moistened, (3) maximum hardness = 1, (4) poor conductivity of heat, (5) partially soluble in acid but decomposed by boiling H_2SO_4, (6) softening in water, (7) after evaporation the volume decreases according to the fatness, and (8) they absorb and retain basic organic colors, ammoniacal gas, and oils. The particular characteristics of a clay are determined by mechanical, chemical, and rational analyses, by firing tests, by tests of absorption on the fired product, tests of compression and breaking, and a new chemical analysis of the fired product to determine the titer of alumina. M.V.K.

Ceramic raw materials used in Italy. KAREL THON. *Stavivo*, p. 663 (1929).—Italy obtains the following raw materials from Czechoslovakia: Zettlitz kaolin, slate from Rakovnik, Moravian argillaceous slate, argillaceous earths from Northern Bohemia, etc. R.B.

Study on adsorption capacity of Russian clays. P. A. ZEMIATCHENSKY AND L. A. SCHMELEV. *Trans. Ceram. Research Inst.* [Moscow], **18,** 40 (1929); *Tonind.-Ztg.*, **54** [79], 1272 (1930). M.V.K.

China clay in Sweden. ANON. *Pottery Gaz.*, **55** [641], 1776 (1930).—The paper industry of Sweden provides a market for china clay, of which the imports amount to over one million kroner yearly, almost the whole of the supplies coming from England. E.J.V.

BOOKS

Limestones: Their Origins, Distributions, and Uses. F. J. NORTH. Thomas Murby & Co., London, 1930. Price 16s. N. is keeper in the Dept. of Geology of the National Museum of Wales. H.H.S.

Geologic Literature of New Mexico. THOMAS PELTIER WOOTTON. State Bureau of Mines and Mineral Resources, *Bull.*, No. 5, 127 pp. Socorro, N. M. Price 25¢. This bibliography of literature on New Mexico lists papers, reports, etc., dealing with the geology of the state. Under this head are included physical, structural, historical, physiographic, and economic geology, geologic formations, mineralogy, petrography, and paleontology. Topographic, geologic, and geographic maps are given, and articles dealing with records of borings, dams and reservoir sites, and underground water are included. Part I, Bibliography, consists of a list of authors and publications. Part II, Index, is an index of the geologic literature of the state. It is given under 19 major heads, and these are further subdivided according to the nature of the material indexed. E.J.V.

Gypsum Industry of Canada. L. H. COLE. Dept. of Mines, Ottawa. Price 30¢. *Can. Chem. Met.*, **14** [10], 52 (1930); see also *Ceram. Abs.*, **8** [6], 397 (1929). E.I.V.

Chemistry and Physics

British investigate fusion point of coal ash. A. C. BLACKALL. *Eng. & Finance*, **21** [5], 265–66 (1929).—B. reports the result of an investigation conducted by the U. S. Bur. Mines in conjunction with the Laboratory of the Fuel Research Station of the British Department of Scientific and Industrial Research to determine whether conditions could be prescribed for fusion-point determinations which would make it possible to obtain concordant results in different laboratories. The results obtained were in satisfactory agreement. The determinations are described. R.G.M.

Precipitation and ignition of magnesium ammonium phosphate. J. I. HOFFMAN AND G. E. F. LUNDELL. Bur. Stand., *Jour. Research*, **5** [2], 279–93 (1930).—Conditions that are necessary for the precipitation and ignition of magnesium ammonium phosphate in determinations of phosphorus or magnesium are described. In addition, observations on the temperatures of platinum crucibles heated over Tirrill, Méker, or Fischer burners with the same gas are reported as well as observations on the losses in weight of platinum crucibles at different temperatures. R.A.H.

Nature of solidity. H. KOTTE. *Stahl Eisen*, **50** [30], 1071 (1930).—The former classification of the states of matter as solid, liquid, and gaseous is being replaced by the classification according to crystalline and amorphous state (by M. Polanyi). In crystalline substances the atoms and molecules are arranged according to definite laws (lattice structure). Metals chiefly belong to these kinds of substances. In the amorphous substances the atoms and molecules are in a state of complete disorder. To this class belong glasses, varnishes, etc. Solidity can be overcome in two ways: (1) by separation of substances (breaking, tearing), a process not yet clearly explained, or (2) by changing the shape of the body. When amorphous materials (glass) change their form, the molecules change places and the greater the temperature, the greater the mobility of the molecules. The plasticity of amorphous bodies, therefore, is greatly dependent on the temperature. In crystalline bodies the plasticity even at highest temperatures changes very little. From the hypothesis that the plastic flexibility of amorphous substances depends on the rearrangement of molecules it follows that the extent of the deformation increases with the length of time while a force is acting on the body. *E.g.*, a blow breaks and a slow acting force changes the form of a glass plate. M.V.K.

Plastic relationships in the technology of plastic materials and products. O. MANFRED AND J. OBRIST. *Z. angew. Chem.*, **41**, 971–77 (1928); *Brit. Chem. Abs.*, [*B*], 733 (1928).—Previous work is reviewed and general data regarding modulus of elasticity, breaking strain, etc., of metallic bodies, cellulose products, casein products, artificial resins, rubber compositions, and clays are discussed from the point of view of the directional or "stream effects." There exists a definite relationship between the degree of plasticity of the raw material and the physical properties of the molded article. The principle of the "aggregation form" is the dominant principle in the technology of plastics. (*J.I.M.*)

Study of clay and clayware. III. V. BODIN AND P. GAILLARD. *Tonind.-Ztg.*, **54** [77], 1250; [81], 1300 (1930); for abstract see *Ceram. Abs.*, **9** [8], 678 (1930). M.V.K.

New method of determining the distribution curve of polydisperse colloidal systems. C. E. MARSHALL. *Proc. Roy. Soc.* [London], **126A** [802], 427–39 (1930).—Various methods of applying the centrifuge to the quantitative mechanical analysis of continuously polydisperse systems are discussed. The method of using high-speed centrifuge is worked out in detail and is applicable within the range 2μ to $20m\mu$. A quantitative fractioning results from one operation by having a thin layer of the polydisperse system on top of a column of the disperse medium. The density of the column below

the colloidal suspension is obtained by dissolving sugar in water. Under conditions suited to clays the accuracy has been reliable to about 1%. G.R.S.

Changes in volume of fired clay bodies. ANON. Bur. Stand., *Tech. News Bull.*, No. 160, p. 78 (1930).—The Columbus station of the Bureau is comparing the change in expansion of several different types of commercially-fired bodies when (1) treated for 3 hours in an autoclave under 150 lbs./sq. in. steam pressure; (2) stored for two 6-month periods in the outdoor air; (3) placed over water in a closed container for two 6-month periods. The results are as follows:

Body	Absorption (%)	Autoclave	Expansion after Treatment Outdoor 6 Months (%)	Outdoor 1 Yr. (%)	Closed Container 6 Months (%)	Closed Container 1 Yr. (%)
Buff wall tile	6.6	0.057	0.016	0.032	0.009	0.025
White wall tile	15.0	0.069	0.053	0.053	0.053	0.070
Terra cotta	12.5	0.056	0.030	0.034	0.025	0.043
White semi-vitreous	9.6	0.071	0.063	0.072	0.053	0.076
Ivory semi-vitreous	7.8	0.065	0.063	0.086	0.048	0.078

The absorption was determined on specimens taken from the autoclave. R.A.H.

Phase equilibria in the system Cr_2O_3-SiO_2. E. N. BUNTING. Bur. Stand., *Jour. Research*, **5** [2], 325–27 (1930).—A study of the phase equilibria in the system Cr_2O_3-SiO_2 has shown that no compounds exist and that the two oxides are practically immiscible in the solid and liquid states. The melting point of Cr_2O_3 was found to be 2140 ± 25°C. R.A.H.

Mechanical analysis of soils without acid pretreatment. L. B. OLMSTEAD AND L. T. ALEXANDER. *Soil Research*, **2**, 68–72 (1930).—Modifications of the International method of mechanical analysis are described. In the pretreatment of the sample, the acid decomposition is omitted and, where manganese dioxide is present in sufficient amount to prevent the satisfactory action of hydrogen peroxide, glacial acetic acid is added in quantity slightly in excess of the equivalent of manganese dioxide. Subsequent filtration and washing of the sample is carried out with a Pasteur-Chamberland candle from which the soil is removed by filling the cone of the candle with distilled water and applying pressure. The washed sample is evaporated to dryness on a steam-bath and baked in an oven at 105°. This permits of determinations of "loss by solution" without interfering with the subsequent dispersion of the sample. The sample is shaken with water containing 10 cc. of 0.5*N*-sodium oxalate and, after separation of the coarser fractions by sieving (up to 300-mesh), the suspension is diluted to 1 liter for analysis by the pipette method for clay ($<5\mu$) and colloid ($<2\mu$). Variations in the amount of sodium oxalate necessary for complete dispersion may be necessary. (*B.C.A.*)

Dispersion and mechanical analysis of certain soils high in sesquioxides. L. T. ALEXANDER. *Soil Research*, **2**, 72–76 (1930).—A sample of bauxite could not be dispersed for mechanical analysis either with sodium oxalate (see preceding abstract) or with ammonium hydroxide, but was completely dispersed with sodium hydroxide (5 cc. of 0.6*N*-solution per liter). Lateritic soils of low silica: sesquioxide ratio and small base-exchange capacity may tend to flocculate in sodium oxalate suspensions and are preferably dispersed in sodium hydroxide. This difficulty arises only when the colloid fraction ($<2\mu$) is required separately, the sodium oxalate method being generally suitable when only the clay fraction ($<5\mu$) is needed. (*B.C.A.*)

Crystal structure of tricalcium aluminate. WHEELER P. DAVEY AND F. A. STEELE. *Phys. Rev.*, **33**, 291 (1929); for abstract see *Ceram. Abs.*, **9** [1], 15 (1930). (*C.A.*)

Sodium silicate: expanding industrial applications. J. G. VAIL. *Chem. Trade Jour.*, **87**, 180 (1930).—The soluble alkali salts are discussed. The principal points

discussed are acid-resisting enamels, silicate paints and cements, and the use of neutral metasilicate as a cleansing agent. See also *Ceram. Abs.*, **8** [4], 308 (1929). (*C.A.*)

Fundamental ceramic tests of earths. O. KALLAUNER. *Repts. Czechoslo. Ceram. Soc.*, p. 59 (1928).—The Czechoslovakian Ceramic Society issued a proposal of standard rules, No. 6, in which directions are given for (1) preparing the samples: a sample weighs 10 to 30 kg. and is dried at a temperature from 100 to 105°C; (2) executing mechanical analysis: the remainders on sieves Nos. 1, 4, 11, 30, 70, and 100 are to be stated in per cents and the part passing through sieve No. 100 must be determined; (3) refractory tests: these tests are the object of special standard regulations; (4) testing the prepared earth to determine its industrial usefulness; (*a*) the quantity of water required to make a plastic mass thereof; (*b*) progressively mixed with 10, 20, 30, 40, 50%, etc., of nonplastic according to the weight of the dry earth; (*c*) molding of test pieces: 5 kg. of prepared clay are kneaded with the determined quantity of water about 15 minutes and the mass is driven through a Maro laboratory press and left in a clean cloth about 24 hrs. Thereupon 15 small brick, 10 x 5 x 2 cm., are molded and slowly dried on wooden frames at 17 to 22°C for 48 hrs. and then for 12 hrs. in a drier up to 105 to 110°C. The following characteristics are determined on the dried test pieces: (1) the quantity of water for the plastic mass (the so-called plastic water (loss of weight by drying)) $m = \frac{v_1 - v_2}{v_2} 100$; v_1 indicates the weight before drying and v_2 the weight after drying; (2) properties in the course of treatment; (3) properties in the course of drying; (4) shrinking during drying is measured by a slide gage; (5) eruptions (rule No. 3 of the Czechoslo. Ceram. Soc.); (6) bonding strength is determined on 3 test brick, laid flat and carried by two supports 6.66 cm. apart. The dried test brick are fired. At least 3 previously dried and weighed brick are fired in an oxidizing heat. The raising of fire lasts 9 hrs. and cooling lasts till the next day. The fired brick are subjected to various tests to determine (1) v_2 = weight of dried test brick, v_3 = weight of dry fired brick, v_4 = weight of saturated fired brick, and v_5 = weight suspended under water; (2) color according to Ostwald scale; (3) sound; (4) shrinking due to firing; and (5) tendency to efflorescence. R.B.

Defects of present testing methods in ceramic branch. O. KALLAUNER. *Repts. Czechoslo. Ceram. Soc.*, p. 158 (1924).—The numerical results of laboratory tests and practice are not always in accordance with one another, especially in the case of ceramic raw materials, as it is of great importance whether the test pieces of these materials are fired in laboratories or in factory furnaces. R.B.

Rational analysis of kaolinitic clays. O. KALLAUNER AND J. MATĚJKA. *Repts. Czechoslo. Ceram. Soc.*, p. 69 (1928).—The Czechoslovakian Ceramic Society has adopted as official the following method of standard analysis of ceramic earths. This method is to be used exclusively in respect to clays with a substantial content of kaolinite, *e.g.*, kaolins, high-class loams, or ceramic masses not containing any matter that might interfere with the carrying-out of the rational analysis. Whether the rational method of analysis is suitable for any clay, *i.e.*, whether the clay is kaolin clay, is best determined by means of the thermal analysis, viz., by comparing the kaolinite curve with the curve obtained by the test of the submitted sample. To carry out the rational analysis proceed as follows: Dry a sample weighing about 20 g. at a temperature of 110 to 120°C to constant weight. Weigh about 5 g. of the sample (V_2), transfer it to a dish, add 50 cc. of water, mix well until a uniform mixture is obtained and while stirring add 50 cc. of hydrochloric acid (h = 1.1). Allow the acid to remain in contact with the sample for a quarter of an hour, stirring the mixture every 5 minutes with a glass rod. After the lapse of a quarter of an hour, filter the acid, wash the residue with water, and dry it again to constant weight at 110 to 120°C. From the loss in weight the quan-

tity of constituents ($U\%$) that can easily be dissolved in hydrochloric acid can be calculated. From the portion dried last, transfer 1 g. to a platinum crucible and heat over a Méker burner or in an electric furnace (at a temperature of 950 to 1000°C) for 30 minutes. By again weighing the crucible, cooled in the desiccator, and by calculating, the loss in weight ($Z\%$) in this portion of the sample is determined. From the same dried sample weigh about 2 g. into a flat porcelain dish (1 cm. high, 4 cm. in diameter), spread the matter over the bottom of the dish in a uniformly thin layer, introduce the dish into an electric furnace on a porcelain tripod so that it does not touch the bottom and the walls of the furnace. Over the layer of the substance, at a distance of about 2 mm., place the soldering of a Le Chatelier electrical heat-controller switch and control the rise in temperature, allowing it to reach 650 to 700°C within an hour. At this temperature let the dish remain in the furnace for another hour. Remove from the furnace and cool in a desiccator. Determine the weight loss ($z\%$). Transfer the contents of the dish to a glass bottle, add 150 cc. of hydrochloric acid ($h = 1.1$) and place the bottle, after introducing a funnel into its neck, into a boiling water bath, taking care that the acid level in the bottle remains under the water level of the hot water bath. Allow the bottle to remain in this condition for 3 hrs., stirring the contents carefully every quarter of an hour so that no solid particles adhere to the sides of the bottle over the liquid. After digestion has taken place, filter the insoluble matter and wash with hot water. Collect the filtrate in a 250-cc. measuring jar, allow it to cool down, and add water to bring the volume up to the mark. Temper and mix thoroughly and remove by means of a pipette, 100 cc. of the liquid, to a porcelain dish. Evaporate to dryness on a water bath. Moisten the residue with 2 cc. of concentrated hydrochloric acid, after 10 min. dilute with hot distilled water, heat 5 min. on a water bath, and filter off the solution. In this filtrate determine the aluminium oxides and ferric oxides in the ordinary way by precipitating them with ammonia as hydroxides; these are filtered, washed, and, by blasting in the electric furnace, converted into oxides which are weighed ($Vs\%$). After drying, remove the portion which remained undissolved in hydrochloric acid from the filter to a black, glossy paper, reduce the filter to ashes, blast the ashes for a short time in a platinum crucible, to which also is added the matter from the black paper. Add to the crucible first about 1 cc. of water, afterward 5 cc. of concentrated hydrofluoric acid and after a quarter of an hour, 1 cc. of sulphuric acid ($h = 1.4$). Allow contents to remain in this condition for about 2 hrs. at an ordinary temperature, and then place on the water bath to drive out hydrogenfluoride. If some portion of the mass remains undisturbed, add more hydrofluoric acid and repeat the procedure. Place the crucible on a sand bath and warm until dense vapors appear. After the crucible has cooled down, remove the contents carefully by means of 5% sulphuric acid and precipitate the solution with ammonia in the ordinary way to obtain sesquioxides. These are filtered, washed, heated, and weighed ($Vs\%$). From the results obtained, the percentages of the various constituents of the sample may be calculated as follows: kaolinite = $2.533\ (Vs - Vz)$, feldspar = $5.47\ Vs$. Quartz = the difference to 100; it is, however, necessary to take into account, besides the aforementioned chief constituents, the portion which can easily be dissolved in hydrochloric acid, ferric oxide, etc. Informatively the kaolinite content is controlled from $7.168\ z$. The carbonates present in some ceramic masses, rarely in pure kaolin clays, such as calcium carbonate, etc., are contained in that portion of constituents which can easily be dissolved in hydrochloric acid. The most suitable furnace for carrying out this rational analysis is the one described in the Bulletin of the Czechoslovakian Assn. for Research and Testing of technically important Materials and Construction of 1919, No. 2. If the sample contains a marked quantity of mica which can be recognized informatively by washing through fine sieves

and by means of a microscope, it will be necessary to determine the alkalis not only in the filtrate after the sesquioxides have been eliminated (*Va*) but also in the original dried sample (*Va*) according to the current analytic methods. In this case kaolinite equals 2.533 $(Vs-Vz)-8.25a$, feldspar = 8.88 $(Va-Va)-2.73\ V's$, and mica = 8.49 $Va-4.237\ (Va-Vs)-3.91\ Vs$. Quartz = is the difference to 100; it is of course again necessary to take into account, besides the aforementioned chief constituents also, that portion which can easily be dissolved in hydrochloric acid, ferric oxide, etc. R.B.

Method for determining silica, alumina, and ferric oxide in silicates. S. SHINKAI. *Abs. of Papers, World Eng. Congress* [Tokyo], Paper No. 139 (1929).—Instead of trying to get a pure silica precipitate by the conventional method, it is recommended to carry out the analysis with added $AlCl_3$ in such a way that eventually a precipitate of SiO_2, Al_2O_3, and Fe_2O_3 is obtained from which the weight of SiO_2 can be obtained from loss in weight after heating with H_2SO_4 and HF. The advantages gained by this unusual procedure are not clear from the abstract submitted by S., himself. (*C.A.*)

Applications of ceric sulphate in volumetric analysis. VIII. Use of methyl red, erio glaucine, and erio green indicators in reaction between ceric and ferrous ions. N. H. FURMAN AND J. H. WALLACE, JR. *Jour. Amer. Chem. Soc.*, **52** [6], 2347–52 (1930); for Part VII see *Ceram. Abs.*, **9** [9], 787 (1930). R.G.M.

Heat capacities of silicon at low temperatures. C. T. ANDERSON. *Jour. Amer. Chem. Soc.*, **52** [6], 2301–04 (1930). R.G.M.

Heat transfer from gas stream to bed of broken solids. II. C. C. FURNAS. *Ind. Eng. Chem.*, **22** [7], 721–31 (1930).—F. presents heat-transfer data for materials of industrial interest such as iron ores, coke, limestone, coal, and a typical blast-furnace charge. Curves are given for the temperature history of a cold bed of broken solids being heated by a hot fluid. A method of determining the coefficient of heat transfer between a gas stream and a bed of particles is given. The temperature history curves of a bed are shown to be applicable when there is a heat of chemical reaction. Equations have been developed for the steady state in countercurrent heat-flow equipment. An illustrative problem involving a foundry cupola is given, using the equations and experimental data presented. For Part I see *Ceram. Abs.*, **9** [5], 389 (1930); see also *ibid.*, **9** [6], 462 (1930). R.G.M.

Analysis of complex gas mixtures. W. L. WOOD. *Fuel Sci. Practice*, **9** [6], 288–91 (1930). R.G.M.

Determination of titanium and iron in rocks. H. HUEBER. *Tschermak's mineral. petrog. Mitt.*, **40,** 192–95 (1929).—TiO_2 is determined colorimetrically with H_2O_2 in the H_2SO_4 solution of sesquioxides and Fe_2O_3 is determined by precipitation with NH_3. (*C.A.*)

Analysis of chromium-bearing silicates. E. DITTLER. *Tschermak's mineral. petrog. Mitt.*, **40,** 189–90 (1929).—About 0.5 g. of material is placed in an Ag crucible with 10 times its weight of Na_2O_2 and melted over a burner. The melt is leached with cold water acidified with HCl, digested, and freed from Ag and AgCl by filtering. The filtrate is treated with H_2O_2 and the SiO_2 determined by a double evaporation and filtration. The residue, after treating the SiO_2 with H_2F_2 and H_2SO_4, is fused with Na_2CO_3 and a little KNO_3 and then added to the filtrate. On making the filtrate ammoniacal the tervalent oxides are precipitated. The precipitate is ignited in a Rose crucible in a stream of H_2 and then placed in an Ag crucible and fused with 10 times its weight of Na_2O_2. Fe_2O_3 remains behind on leaching the cold melt. H_2O_2 is added to the filtrate to precipitate MnO_2, which is redissolved and titrated as Mn^{++} with $KMnO_4$. Cr is determined in the filtrate by iodometric titration, gravimetrically or colorimetrically. The method is successful for Cr-bearing spinel, fuchsite, pyroxenes, garnet, chromite, and all Cr-bearing silicates. (*C.A.*)

Thermal dissociation of pyrite. LOUIS D'OR. *Jour. chim. phys.*, **27**, 239–49 (1930).—FeS_2, sealed within a quartz absorption cell at a pressure of 10^{-4} mm., was heated in an electric furnace provided with quartz windows; with light from an Al arc, absorption spectra of the vapor were photographed at various intervals of time at temperatures ranging from 470 to 660°. The dissociation of FeS_2 is strictly reversible under its own vapor pressure at the temperatures used. Neither the FeS_2 nor the quartz dissolves (or absorbs) S. (*C.A.*)

Identification of barite, quartz, and silicates. H. WAGNER. *Farben-Ztg.*, **35**, 2174–75 (1930).—The barium flame test as a means of identifying barite is not satisfactory. Barite can be distinguished from gypsum, but not from quartz, by its appearance in polarized light. Adsorption of dyestuff (brilliant green) is not a successful means of identification. The immersion of the specimen in a refractive medium and examination under a low microscopical magnification is advocated. With phenylthiocarbimide as the medium, barite appears blue and can be clearly identified, although the method may fail under some special conditions. (*B.C.A.*)

Advantages of expansion measurements of solid bodies by means of mechanical and photographic registering methods. WILLI M. COHN. *Chem. Fabr.*, pp. 257–58 (1930); see also *Ceram. Abs.*, **9** [7], 548; [8], 625 (1930). (*C.A.*)

Barium aluminates. ERNEST MARTIN. *Chim. & ind.*, **23**, 564–72 (1930); for abstract see *Ceram. Abs.*, **9** [9], 785 (1930). (*C.A.*)

Building drying tunnels and tunnels for hot air. O. KALLAUNER. *Repts. Czechoslo. Ceram. Soc.*; p. 25 (1928).—K. recommends that these tunnels be built of cement tubes, which support up to 150°C, or of earthenware tubes. When connecting these tubes a clearance of about 0.5 to 1 cm. is left free and sealing is effected by means of airproof packing material. The heat losses and friction of walls are thereby minimized and drawing-off can take place at a greater depression and in a more rapid manner. Dead air is not desired. R.B.

Combined use of photoelectric cell and projection microscope. ALFRED SAVAGE AND M. C. JAMIESON. *Can. Jour. Research*, **3** [4], 322 (1930).—A method is described whereby the comparative areas of irregularly-shaped microscopic objects may be rapidly determined. It consists of staining them with fuchsine and projecting their magnified images into a photoelectric cell insensitive to red light. The photoelectric current is inversely proportional to the size of the images and at low magnification may be measured with a sensitive galvanometer. W.L.

Photographing cooling curves. H. D. CROCKFORD AND A. E. HUGHES. *Jour. Phys. Chem.*, **34** [11], 2624–26 (1930).—The following are essential features of the apparatus used in photographing a cooling curve. A beam of light from a Mazda lamp, incased, and fitted with a collimator over the end of which is placed a slotted shield, is allowed to fall on the galvanometer mirror. The mirror is covered with black Duco paint except for a fine scratched line in the paint, reducing the ray of light reflected from it to about 1 mm. in thickness. The beam of light is reflected to the photographic film held on a wooden drum 3 in. in diameter and 11 in. long placed inside a shield fitted with a fine horizontal slit. The drum is revolved by clockwork at constant speed. The room is made dark save for a shielded light which illuminates the scale. The light ray from the galvanometer registers temperature, while the revolving drum registers time. The temperatures at the start and stop of the drum are read. The freezing points and eutectics can then be obtained from the cooling curve. Freezing points were checked to an accuracy of 0.1°C. G.R.S.

Science and practice in ceramics. A. ZOELLNER. *Keramos*, **9** [19], 13 (1930).—This essay is written on the occasion of the meeting of the German Ceramic Society and states that ceramic science is far ahead of ceramic practice. Material worked

out by science has not been used to a full extent in practice. To help this difficulty, Z. asks for a review of the scientific achievement of the last ten years, arranging all published essays and experiments under certain viewpoints, *e.g.*, raw materials, firing, bodies and glazes, technique of firing, plant control, etc. He mentions especially the appliance of microscopic examinations in practice, a method which has been a great help in science, but has been seldom applied in practice. I.R.

Plasticity of clay products. ANON. *Brick Clay Rec.*, **77** [10], 551–56 (1930).—This article covers a few of the theoretical considerations of plasticity. Various theories and explanations for this property of clay and a few means of determining workability of a clay are given. As an appendix to the theoretical discussion are a few communications from A. F. Greaves-Walker, H. R. Straight, C. U. Hendershot, Roy C. Wallis, and O. J. Whittemore, who give their views as to some practical means of obtaining best results in plant practice. E.J.V.

Structure of enstatite, $MgSiO_3$. B. E. WARREN AND D. I. MODELL. *Z. Krist.*, **75** [1–2], 1–14 (1930).—From rotation photographs made by rotating a hypersthene crystal about the three principal axes, the axial lengths were calculated as $a = 18.20$ Å, $b = 8.86$ Å, $c = 5.20$ Å. Comparison with the crystallographic axial ratio shows that the previously accepted "a" axis must be doubled. From a series of 15° oscillation photographs about the three principal axes, indices were assigned to about 300 reflections. Assuming holohedral orthorhombic symmetry, the space group is found to be V_h^{15}. There are 16 molecules $(Mg, Fe)SiO_3$ in the unit cell. There is a close connection between the diopside structure and the space group V_h^{15}, such that with slight alterations, the whole diopside unit cell can be inserted in the half-unit cell of the enstatite space group. Ca in diopside is replaced by Mg and approximate coördinates obtained for all the atoms in the enstatite structure. Calculated amplitude contributions for about 50 planes compare favorably with the visually estimated intensities of the corresponding spots. The unit cell of the orthorhombic pyroxene is very nearly two cells of the monoclinic pyroxene joined together on the "a" face through a glide plane of reflection. The characteristic and distinguishing features of the pyroxenes and amphiboles lie in the possession of the single and double type of silicon-oxygen chains. Enstatite has the single type of chain and the orthorhombic pyroxenes are to be classified as true members of the pyroxene group. G.R.S.

Internal pressures in adsorbed films. P. G. NUTTING. *U. S. Geol. Surv.; Jour. Wash. Acad. Sci.*, **19** [14], 295–300 (1929).—Simple thermodynamic definitions of kinetic and cohesive pressure are given, applicable to any homogeneous system in equilibrium. The simple relation between internal pressures and concentration are pointed out in contrast to equations of state. The principles developed were applied to calculations of surface tension directly from vapor pressure. Cohesive pressures in adsorbed films are shown to be derivable from vapor pressure and from temperature data. The essential relation between excess cohesive pressure and osmotic pressure are pointed out. E.C.C.

Ceramics and science. FELIX SINGER. *Keramos*, **9** [19], 5 (1930).—In this letter to a colleague, written on the occasion of the meeting of the German Ceramic Society in Nuremberg, S. writes of the generally poor conditions in ceramic industries and gives some ideas toward assistance. (1) He considers the shortening of the production time by mechanization of the production, especially the drying. (2) It is important to raise the quality of the product. (3) He asks for a more frequent use of the progress of science as applied to the ceramic industry. This letter requests a better help from scientific institutions in Germany, in order to make known more about ceramic raw materials as well as incidents during firing. I.R.

Action of $Ca(OH)_2$ on aluminium metal. GUNNAR ASSARASSON. *Z. anorg. all-*

gem. Chem., **191** [4], 333–39 (1930).—In these studies, strips of aluminium metal were suspended in limewater. The residue was examined after definite periods of time. In saturated limewater at 0 to 17 °C, needle crystals were found with indices $\omega = 1.533$; $\xi = 1.514$. Hexagonal plates were also present which were uniaxial negative. Indices of refraction: $\xi = 1.53$; ω was indeterminable because of the fineness of the crystals. An amorphous aluminium hydroxide was also found. In dilute limewater the reaction was very slow. Very thin plates were found which had a composition $3CaO \cdot Al_2O_3 \cdot 12H_2O$. Indices of refraction of these plates were: $\omega = 1.53$; $\xi = 1.51$. At 22 °C in saturated limewater the phase consisted largely of tetracalcium aluminate hydrate with only a few plates of the tricalcium aluminate hydrate. There was present also a phase consisting of icosatetrahedrons with an index of refraction 1.603. It was possible to prepare this phase in a pure state; its composition was then found to be $3CaO \cdot Al_2O_3 \cdot 12H_2O$. In saturated limewater at 40 °C the two tricalcium aluminates with six and twelve molecules of water were formed. In dilute limewater at this temperature the phase consisted almost entirely of the hexagonal plates with a composition $3CaO \cdot Al_2O_3 \cdot 6H_2O$. At 60 to 90 °C in saturated limewater the icosatetrahedrons of composition $3CaO \cdot Al_2O_3 \cdot 6H_2O$ and index of refraction 1.603 were formed in practically a pure state. L.T.B.

BOOKS AND CATALOGUES

Structure of Silicates. W. L. Bragg. Academic Publishing Society, Leipzig, 1930. 24 illustrations. Price Rm. 5. Reviewed in *Sprechsaal*, **63** [40], 770 (1930); *Z. Krist.*, **74** [3–4], 237–305 (1930).—A summary is given of the results obtained in numerous X-ray analyses of silicate structures. Silicates are distinguished from other inorganic compounds by the way in which (SiO_4) groups can be linked together to form silicon-oxygen complexes with indefinite extension in space. This gives a variety of silicate structures. The rôle which silicon plays in the inorganic world compares with that which carbon plays in organic chemistry except that any linking between one silicon atom and another is always through an intermediate oxygen atom. Aluminum has a dual rôle, replacing silicon or magnesium in many minerals, so that there is a continuous gradation of properties in this row of the periodic table. Silicon also forms the simple group $(SiO_4)^{4-}$ in the orthosilicates, and more complex self-contained groups. In such cases, the structure is thought of as built of discrete acid radicals and metallic ions, like other inorganic salts. It is the existence of the acid radicals with indefinite extension in space, which is so exceptional a feature. It explains the difficulty in writing formulas for the silicates. Such structural formulas must take into account the spatial extension of the silicon-oxygen groups in order that their significance may be clear. This recalls the stereochemistry of organic compounds, though the fundamental features are very different. In all the structures which have been analyzed, silicon is found between a regular group of four oxygen atoms. The distance between silicon and oxygen is about 1.62 Å and that between oxygen centers about 2.6 Å. Quantitative X-ray measurements indicate that more electrons are associated with silicon, and fewer electrons with each oxygen atom, than would be the case if silicon had a charge $4e$ and oxygen a charge $-2e$. The inner constitution of the group is not of primary importance when the way in which it is incorporated into the silicate structure is considered. The whole group behaves as if a charge $-4e$ were equally distributed among the four oxygen atoms. These atoms, like other oxygen atoms not attached to silicon, obey the general rule of an approximate distance of 2.7Å between oxygen centers. In the orthosilicates the SiO_4 groups are independent. In other silicates, the linking between SiO_4 groups takes place through one oxygen atom being common to two groups (sharing of corners between tetrahedra). An oxygen atom which is thus shared has little residual attraction for other atoms. This may be regarded as due to a balance of

electrostatic valence, the double charge on the oxygen atom being neutralized by the lines of force coming from the two silicon atoms on either side. Alternately, the bonds may be regarded as homopolar and similar to those in organic compounds. The result as far as external field is concerned, is the same. Oxygen atoms attached to two silicon atoms have no residual valency, while those attached to one silicon atom behave as if they had a charge $-e$. The single charges on these latter oxygen atoms, along with charges on other ions O'', OH', F' are neutralized by metallic ions. Types of silicon-oxygen complex which differ in their spatial extension and which are all formed by the linking together of the simple SiO_4 groups of the orthosilicates may be distinguished as follows: (1) Self-contained groups, represented by the formulas $(Si_2O_7)^{6-}$, $(Si_3O_9)^{6-}$, $(Si_4O_{12})^{8-}$, $(Si_6O_{18})^{12-}$. The two linked tetrahedra of the diorthosilicates and the six tetrahedra in a ring of beryl are examples. Such groups may be regarded as complex acid radicals joined by metal atoms as in a salt. (2) Silicon-oxygen chains are the simplest form, and the row of linked tetrahedra, each sharing two of its oxygen atoms, has the composition $(SiO_3)^{2-}$. In the amphiboles a further condensation $(Si_4O_{11})^{6-}$ takes place by the linking of two such chains side by side, a process which if continued would result in the type of linking in the next group. (3) Silicon-oxygen sheets, which are supposed to be characteristic of the mica-like minerals. If three oxygens of each tetrahedral group are linked to other groups, the fourth remaining free, the oxygen silicon ratio is represented by $(Si_2O_5)^{2-}$. (4) Three dimensional silicon-oxygen networks, as in the forms of silica. A partial replacement of Si by Al results in a three-dimensional negatively charged network, like a vast extended acid radical in which metal atoms can be incorporated. Zeolites are striking examples where the network remains unaltered when metallic ions are substituted for each other, and the water content varies. These successive spatial extensions represent a successive decrease in the oxygen silicon ratio as illustrated by the following cases: SiO_4 orthosilicate group, Si_2O_7 complex group, SiO_3 chain, Si_2O_5 sheet, and SiO_2 or $(Si, Al)O_2$ three dimensional network. These silicon-oxygen groups are bound together by metal atoms which are found inside more or less regular groups of the oxygen atoms. As a general rule the metals to which smaller ionic radii are assigned are surrounded by a lesser number of oxygen atoms and the group is more regular in form. The type of grouping around metal atoms varies from crystal to crystal since it must conform to the greater rigidity of the silicon-oxygen complex. In the case of certain metals common in the silicates, the groups are so regular that it is convenient to regard the structure as built of group units (expressed by Pauling as a linking of regular polyhedra by sharing corners, edges, and faces). In the case of other cations, *e.g.*, Na, Ca, and K the group is so regular as to lose its individuality. The most general description of the structures is one of silicon-oxygen complexes, which come together so that their large oxygen atoms form with each other more or less regular groups. Into these groups the metal atoms are packed and bind together the whole structure. Aluminum can partially replace silicon in the complex groups. The classification of a silicate structure into one of the above types may depend on whether the aluminum within tetrahedral groups is ranked with silicon or not, and the boundary between the types is in consequence somewhat arbitrary. In isomorphous replacement, the number of oxygen atoms (and of F atoms of OH groups) in the unit cell remains constant. Changes in composition take place by the substitution of Si by Al, of Al, Mg, and Fe by each other, of Na by Ca, etc. When a silicate is analyzed, the atomic composition should be expressed on the basis of a constant number of oxygen atoms characteristic of the type of structure. The great importance of oxygen in expressing the atomic composition was largely overlooked before X-ray analysis was applied. B. proposed in 1927 that a silicate should be regarded as a structure having a constant number of oxygen atoms in the unit and with

a constant number of places for metal and silicon which can be filled by these elements in varying proportions consistent with a balance between valencies. This view has been amply supported by subsequent work. In packing together, features appear which result from the natural consideration that the arrangement must be such as to represent the least potential energy and the greatest stability of the structure. Pauling's rule of balancing of electrostatic valency expresses this principle. It may be stated in the broadest way as signifying that the positive ions are so dispersed among the negative ions that a local neutralization of electric charge is effected throughout the structure. Lines of force can be drawn from cation to anion which represent numerically their electric charges and which stretch between nearest neighbors. These two hypotheses can be fertile in suggesting why certain silicates exist and others do not. If a model of a silicate structure be made with bonds linking the oxygen atoms (and F or OH) to the atoms of metal and silicon, it shows certain features which give a striking impression of mechanical stability and balance between opposing forces. The regular grouping of the oxygen atoms around the metal atoms has been discussed; it is interesting to consider the grouping of the metal or silicon atoms around each oxygen atom. An oxygen atom in general lies between two, three, or four "cations." If between two, which must be two silicon atoms or one silicon atom and such an atom as aluminum or boron, the two bonds are approximately in line. If it lies between three, they represent an approximate "triangle of forces." The forces of repulsion between the oxygen atoms represented by their "packing," and the rigidity of the SiO_4 groups, modify this equilibrium but it remains a characteristic feature of the structure and is of assistance in analysis. The F atom or the OH group is frequently found in a position where the bonds all lie in one hemisphere. This may be due to the weaker bonds being overmastered by the necessities of packing, or to a polarization of the group. The arrangement of bonds around each ion is equally a result of the wide dispersal of the cations, of the sharing of a minimum number of anions between neighboring cations, or of the electrostatic valency rule. These features are alternative ways of expressing the tendency of the stable configuration to have a form of the lowest potential energy. G.R.S.

Pressure Multiplier Tables. PITTSBURGH EQUITABLE METER CO. Reviewed in *Gas Age-Rec.*, **66** [19], 782 (1930).—This is a set of multiplier tables, the factors of which are used to convert volumes at higher pressures to volumes at a given base pressure. Multipliers are based on Boyle's law. Instructions for the use of these tables are also given. E.J.V.

Quantitative Spectral Analysis of the Elements and Its Use in Biological, Agricultural, and Mineralogical Fields. (Die quantitative Spektralanalyse der Elemente und ihre Anwendung auf biologische, agrikulturchemische und mineralogische Aufgaben. HENRIK LUNDEGARDH. Gustav Fisher, Jena, 1930. 20 M. *Z. phys. Chem.*, **150A** [2], 175 (1930).—This is a detailed book on quantitative spectral analysis. It is well illustrated with spectrograms and furnishes an excellent introduction to this field of applied science. L.T.B.

Coal Carbonization. R. WIGGINTON. *Gas Jour.*, **189** [3476], 34 (1930); see also *Ceram. Abs.*, **9** [11], 970 (1930). G.R.S.

Modern Physics. THEODOR WULF. Translated from the 2nd German edition by C. J. Smith. Methuen & Co., London, 1930. Price 35s. Reviewed in *Spectator*, No. 5328, pp. 196–97 (1930).—This is a masterly conspectus of the immense advances made in physics in this century. H.H.S.

Chemical Dictionary. (Wosterbuch der Chemie) Vol. 1. English-German. A. TETZLAFF, Berlin-Schoneberg, 1929. *Z. phys. Chem.*, **150A** [2], 175 (1930).—This is a small useful dictionary of 17,000 words. L.T.B.

Catalogue of British Scientific and Technical Books. Compiled by DAPHNE SHAW. 3rd ed. 754 pp. British Science Guild, London, 1930. Price 20s, net. Reviewed in *Colliery Guard.*, **141** [3641], 1353 (1930).—The third edition of this catalogue shows considerable developments in both the quantity and the presentation of the contents. The subjects have been increased to 64 and the sections to 694, while the 13,915 titles are more than double those in the original edition of 1921, and show an increase of over 5000 compared with the last edition of 1925. E.J.V.

Constitution and Thermochemistry of Molecules. (Constitution et Thermochemie des Molecules.) ALBERT AND MARCEL GOSSELIN. Les Presses Universitaries de France, Paris. Reviewed in *Can. Chem. & Met.*, **14** [10], 52 (1930).—This book is a discussion of theories relating to valency and the general structure of molecules. The theory of Werner as applied to complex inorganic arrangements is given in detail. In the organic field, the various views that have been expressed on formulas are well presented together with considerable data relating heat formation to the creation and construction of organic arrangements. The mechanism of standard organic reaction is traced, having in mind the evidence of experimental work and the various theories that have been built up around that evidence. The book presents a great deal of information and is a good review of the modern conception of atomic and molecular action from the chemical standpoint. E.J.V.

Metallurgists and Chemists Handbook. D. M. LIDDELL. McGraw-Hill Book Co., N. Y., 1930. Third edition revised. 847 pp. $5.00. Reviewed in *Mining & Met.*, **11** [287], 12 (1930).—This third enlarged edition has been increased in size about one-third by L. to permit him to include in it the metallurgical and chemical advances that have been made since the second edition was issued in 1918. William Campbell has revised the alloys table. In spite of these additions the bulk of the volume has been kept down to convenient pocket size. E.J.V.

Crucibles: The Lives and Achievements of Great Chemists. BERNARD JAFFE. Simon & Schuster, N. Y., 1930. Price $5.00. Reviewed in *Discovery*, **11**, 318 (1930).—A review of the book that won the $7500 Francis Bacon award for the humanizing of knowledge is given. H.H.S.

PATENT

Sodium silicate. UNION CHIMIQUE BELG. SOC. ANON. Belg. 363,878, Oct. 31, 1929. Na carbonate, sulphate, or phosphate is made to react on crude phosphoric acid produced by the action of acids on natural phosphates containing fluosilicic acid. (*C.A.*)

General

Rational working of ceramic factories. KAREL HINEIS. *Repts. Czechoslo. Ceram. Soc.*, p. 8 (1924). R.B.

Value of systematic studying. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **9** [11], 299–300 (1930).—Numerous examples of success gained through continued systematic study are cited, as are some examples of lack of progress due to discontinuing systematic study. It is pointed out how the AMERICAN CERAMIC SOCIETY is primarily a means for coöperative aid in continued studying out of the applications of observed facts to the economic production of high-quality ceramic ware. E.J.V.

Need of digest of technical data. EDITORIAL. *Jour. Indian Ceram. Soc.*, **2**, 79 (1930). A.A.

Bonus methods of wage payment. H. R. STRAIGHT. *Brick Clay Rec.*, **77** [9], 488–92 (1930); see also *Ceram. Abs.*, **9** [6], 479 (1930). E.J.V.

Standard sand. ANON. *Tonind.-Ztg.*, **54** [85], 1347 (1930).—German standard sand is obtained from a quartz sand deposit near Freienwalde on the Oder. The sand is washed and dried at 120°C and the standard sand must contain at least 99% silicic acid. The content of ingredients which can be washed off must amount to not more than 0.05%. Residue on sifting through a 1.36-mm. sieve must not exceed 2%. M.V.K.

Silicate wool and insulating materials for high temperatures. HEINRICH GÜNTHER. *Feuerungstechnik*, **18** [19–20], 194–95 (1930).—The best insulating materials for high temperatures of 1000° and more are obtained from magnesium and calcium silicates prepared from natural minerals, blast-furnace slag, or artificial products. The most valuable properties of these insulating materials are their small thermal conductivity, small specific heat, and sufficient solidity. Their insulating capacity depends on their porosity, as it is in reality the air contained by the numerous small pores in the silicate which insulates. The high-insulating capacity is therefore due to the air sealed up in the pores of the silicate which does not circulate among them. By a special treatment of the silicate, blast-furnace slag, etc., products of a favorably determined porosity are obtained. The process consists in dusting or atomizing the silicate fusion with steam or air. Especially suited for this process are blast-furnace slag, a mixture of calcium silicates with silicic acid, iron, and aluminum. Different German processes for obtaining silicate wool for insulating materials are described. M.V.K.

Water softening: some properties of certain base-exchange material. I. A. R. MARTIN. *Chem. & Ind.*, **49** [40], 390–94 (1930). G.R.S.

Method of treating clays to overcome drying defects. J. G. PHILLIPS. *Trans Can. Inst. Min. Met.*, **32**, 270–82 (1929); for abstract see *Ceram. Abs.*, **9** [2], 104 (1930). (*B.C.A.*)

Industrial research acquires a million-dollar plant. H. HORNBOSTEL. *Eng. News-Rec.*, **104** [25], 1013 (1930).—The new laboratory built for the research laboratories of the Alumina Company of America is described. W.L.

Open-air (Folk) museums. E. N. FALLAIZE. *Discovery*, **11**, 306–10 (1930).—The essential feature of the type of museum which is known on the Continent as "Folk," and in England as "Open-air," is that the exhibits are not housed in one building, and that the buildings themselves and the lay-out of the grounds are part of the exhibit, illustrating the types of architecture, etc., at different periods and in different areas. Illustrated by photographs of Aarhus, Denmark. H.H.S.

Ceramics at Iowa State Fair. ANON. *Clay-Worker*, **94** [4], 243 (1930); *Bull. Amer. Ceram. Soc.*, **9** [11], 322–23 (1930).—Ceramic work was well represented at the Iowa State Fair, every kind of clay product being on display, showing that Iowa is rapidly becoming ceramically conscious. E.J.V.

International nitrate agreement. ANON. *Times Eng. Supp.*, **26**, 529 (1930).—The international conference which restarted at Ostend in June, and continued in Paris under the chairmanship of Herr Schmitz, has come to an agreement which covers all countries outside the U.S. H.H.S.

Common interests in fuel burning fields. T. A. MARSH. *Blast Fur. Steel Plant*, **18** [11], 1716–18 (1930).—The problem confronting the public, regardless of their classification as members of the community, is (1) to provide better service by way of heating to the purchaser; (2) to effect economies in over-all costs so that heating and power bills will be lowered; (3) to produce smokeless combustion; (4) to provide the maximum convenience possible in burning coal in heating plants; (5) to provide automatic operation to the highest degree possible; and (6) to make a profit in the respective business in which they are engaged. A discussion of the factors connected with each of these phases of the problem is presented. E.J.V.

Pulverized coal plant at Peterborough electric works. ANON. *Eng. & Finance*, **21** [4], 202–204 (1929). R.G.M.

Circulation in water walls. S. M. FINN. *Eng. & Finance*, **21** [5], 262–63 (1929). R.G.M.

Heat transmission in experimental inclined tube evaporator. C. M. LINDEN AND G. H. MONTILLON. *Ind. Eng. Chem.*, **22** [7], 708–13 (1930). R.G.M.

Wind pressure on circular cylinders and chimneys. H. L. DRYDEN AND GEORGE C. HILL. Bur. Stand., *Jour. Research*, **5** [3], 653–91 (1930).—In this paper a summary is given of the published model experiments on the wind pressure on cylinders and of some previously unpublished experiments made at the Bureau on models, on a large cylinder in natural winds, and on the power plant chimney in natural winds. This information is collected and analyzed for the purpose of estimating the wind pressure on chimneys and other cylindrical structures at known wind speeds. R.A.H.

Summer meeting of American glass technologists. F. W. PRESTON. *Glass Ind.*, **11** [11], 252–54 (1930).—A well illustrated report of the meeting held at Cove Point, Md., the first week-end in October, is presented by one of the participants. See also *Bull. Amer. Ceram. Soc.*, **9** [11], 312–14 (1930). E.J.V.

Feldspar Grinders' Institute, Spruce Pine Meeting. ANON. *Glass Ind.*, **11** [11], 269 (1930).—A report of the meeting held at Spruce Pine, N. C., September, 1930, is given. E.J.V.

Glass Convention; past achievements and future policy. ANON. *Pottery Gaz.*, **55** [641], 1747–51 (1930). E.J.V.

The Ceramic Society. ANON. *Pottery Gaz.*, **55** [641], 1754–56 (1930).—A report of the banquet of the Refractory Materials and Building Materials Sections is presented with brief summaries of addresses and toasts offered and proposed. E.J.V.

German Glass Technical Society. ANON. *Sprechsaal*, **63** [42], 799–800 (1930).—The German Glass Technical Society held a meeting in Berlin, November, 1930. The program of the meeting and reports for discussion are given. M.V.K.

Working program of the Czechoslovakian Ceramic Society and of its committees. ANON. *Repts. Czechoslo. Ceram. Soc.*, 1924. R.B.

Shortage of building materials in U.S.S.R. ANON. *Econ. Rev. Soviet Union*, **5** [18–19], 391 (1930).—The shortage of cement and other building materials in U.S.S.R. ranged from 20 to 50% of the demand during the spring because of the great increase in building activities. Progress has recently been made in rationalizing the brick industry, production being doubled, and costs reduced 20% at the fifty-three plants of the Orgkipich Brick Trust. See also *Ceram. Abs.*, **9** [8], 687 (1930). M.V.K.

Sheet glass situation in Czechoslovakia. SAM. E. WOODS. *Commerce Repts.*, **44**, 307 (1930).—While exports of sheet glass from Czechoslovakia during 1929 increased 15% over those of 1928, domestic sales decreased about 20%. Sales during the first seven months of 1930 show a declining tendency, and the outlook is very unfavorable. Increases in the U. S. tariff rates on sheet glass practically close that market to Czechoslovakia. E.J.V.

Survey of the Czechoslovakian glass industry. OTAKAR WEBR. *Chem. Listy*, **23**, 638–40 (1929). (*C.A.*)

Belgian glass producers form new combine. WALTER H. SHOLES. *Commerce Repts.*, **42**, 175 (1930); *Glass Ind.*, **11** [11], 270 (1930).—A recent outstanding development in the Belgian plate and window glass industry is the formation of a trust to be known as the "Union des Verreries Mécaniques Belges, Systeme Fourcault," comprising 13 glass mills, owning together 18 tanks, with a capital of $5,600,000. E.J.V.

Imports of glassware into India. ANON. *Pottery Gaz.*, **55** [641], 1788 (1930).—The enormous trade in glass bangles and beads for 1929 to 1930, aggregating nearly

$5,000,000 in value, is a specialty of Czechoslovakia and Japan. Germany is a competitor in bangles, and Italy and Austria compete in beads. The imports of soda-water bottles were drawn from the United Kingdom (40%) and Germany (53%). The British trade has for some years tended to decrease in view of the heavy import of cheap bottles from Germany. E.J.V.

Indian glass industry. ANON. *Pottery Gaz.*, **55** [641], 1776 (1930).—Three new glassware factories were opened in the United Province of India during the fiscal year 1928 to 1929. Though glassware manufacturers in the United Provinces suffered heavily from Japanese and Austrian competition between 1921 and 1924, they have since effected economies permitting price reductions. Indian-made chimneys for America have been cut nearly half in price. E.J.V.

Glass industry in Mexico. ANON. *Pottery Gaz.*, **55** [641], 1779 (1930); for abstract see *Ceram. Abs.*, **9** [11], 931 (1930). E.J.V.

Lithuania assists brick manufacture. ANON. *Christian Sci. Mon.*, **22** [272], 4 (1930).—There are good prospects for the development of the brick industry in Lithuania with no lack of raw material such as clay in the country and the demand for brick continually increasing. The Lithuanian Government assists the brickmakers by granting them the necessary credit for the erection of kilns. At present there are about 200 brick kilns in Lithuania, of which about 20 produce 200,000 to 1,000,000 brick and about 70 produce 50,000 to 200,000 brick a year. The remaining 110 kilns have a yearly production of about 20,000 pieces. E.J.V.

Sand-lime brick production declined in 1929. ANON. *Can. Chem. Met.*, **14** [10], 38 (1930).—The output of the 12 plants operating in this Canadian industry last year amounted to $953,726, a 14% decrease from the previous year's production. Materials used were valued at $264,465, including quicklime worth $140,784 and sand worth $121,628. E.J.V.

Northern Bavaria as production territory for whiteware. INSTITUTE FOR BUSINESS OBSERVATION, NUREMBERG. *Keramos*, **9** [19], 45 (1930).—This essay gives more data on the development of the ceramic industry in Bavaria. The question of location of the different plants, the market of the Bavarian porcelain, and the center of faulty porcelain in Marktredwitz are discussed. I.R.

British pottery at Canadian National Exhibition. ANON. *Pottery Gaz.*, **55** [641], 1753 (1930).—A discussion of the exhibits of the six British potteries participating in this year's Exhibition is presented with photographs of some of the exhibits. E.J.V.

Canada's tile industry and requirements. GEORGE GREGG FULLER. *Commerce Repts.*, **45**, 360–61 (1930).—American floor tile are reëntering Canada, a market which was lost after the war. The English tile is considered the best, with American second. The American loss of the Canadian market for both glazed and floor tile was due to preferential tariff and freight rates. The prices of American tile have been reduced. A larger market awaits American manufacturers if they can sell for 16¢ a foot or less. E.J.V.

Pottery and glass market in Italy. ANON. *Pottery Gaz.*, **55** [641], 1731 (1930).—The ceramic industry in Italy has distinctly improved generally and the past three months have been satisfactory. The electrical porcelain makers are busy, while those engaged in kitchen and tableware are said to have plenty of orders. Makers of refractories are also well occupied. The white glass business is also better, with prospects of a distinct revival. Producers of machine-made sheets anticipate a good season. Conditions, however, in the artistic glass business are unsatisfactory. E.J.V.

Changes in market conditions of German whiteware products in foreign countries. WALTER DEHN. *Keramos*, **9** [20], 60 (1930).—Closing articles of previous volumes of this year, considering the conditions on the two American continents, are given. I.R.

Ceramic industry in Australia. C. CALLISTER. *Repts. Czechoslo. Ceram. Soc.*, p. 3 (1928).—The first branch of ceramic industry in Australia was the brick trade, the development of which progressed with the growth of the towns. The standard size of brick is 9 x 4.5 x 3 in., and they are mainly produced by dry pressing. Annular furnaces are used mainly in New South Wales, otherwise periodical furnaces are used. Grooved tile are fired in compound square furnaces using waste heat. For the manufacture of refractory goods, kaolins formed by decay of granite or special argillaceous earths are used. The production in 1925 was 748,000 brick, 578,000 T. cement, 100,000 T. lime (mainly from pit furnaces), 100,000 T. gypsum (Southern Australia and Victoria), and 5000 T. of kaolin. R.B.

Canadian market for Italian ceramic products. ANON. *Corriere Ceram.*, **11** [9], 361–69 (1930).—The ceramic industry in Canada is reviewed and data on the home production and importation of raw materials and fired ware are given. The import trade is practically monopolized by England because of the preferential tariff in the Empire, and by the U.S. because of its territorial proximity. With the increasing development of the Dominions it is conceivable that other European countries could find a market there for their products. In order to do this, they must not only offer the highest quality products at competitive prices, but also maintain a foreign agency with materials on hand ready for sale, thus eliminating long waits because of distances. Kaolin, refractory clays, and small majolica tile are the most important imports. M.V.K.

Ceramic industry in Czechoslovakia. RUDOLF BARTA. *Chem. Listy*, **24**, 185–87 (1930); for abstract see *Ceram. Abs.*, **9** [6], 483 (1930). (*C.A.*)

Import and export of ceramic products of Holland during first half of 1930. ANON. *Keramos*, **9** [20], 755 (1930). I.R.

Studies concerning German trade balance for ceramic ware. WILHELM VERSHOFEN. *Keramos*, **9** [20], 739 (1930).—The dangers of an increased importation of ceramic ware into Germany are looked over, especially the Japanese industry, which seems to be getting hold of the German market. See also *Ceram. Abs.*, **9** [12], 1113 (1930). I.R.

Importation of ceramic products into the Belgium Luxembourgh tariff territory, in the first half of 1930. ANON. *Keramos*, **9** [20], 753 (1930). I.R.

Mandatory goggle rule protects eyes of workers. HARRY GUILBERT. *Abrasive Ind.*, **11** [11], 27 (1930).—The National Society for the Prevention of Blindness estimates that eye accidents cost American industries $50,000,000 a year. There is only one method of preventing these occurrences and that is by enforcing the universal wearing of goggles by industrial employees. The use of goggles in grinding operations is often of vital importance. E.P.R.

BOOKS

Text Book of Ceramics. A Description of Ceramic Products and Their Technical Structure. (Lehrbuch für Keramic. Eine Darstellung der keramischen Erzeugnisse in ihrem technischen Aufbau.) HERMANN HECHT. Urban and Schwarzenberg, Berlin and Vienna, 1930. 467 pp. 193 illustrations. Reviewed in *Tonind.-Ztg.*, **54** [80], 1285 (1930).—The first part of the book treats the basic aspects of ceramics as a whole, while the second part is devoted to the separate industries. M.V.K.

Corrugated Transite. JOHNS-MANVILLE CORP. 20 pp. Reviewed in *Brick Clay Rec.*, **77** [10], 558 (1930); *Gas Age-Rec.*, **66** [19], 782 (1930).—An interesting booklet describes Transite. It shows the use of Transite on clay plants. E.J.V.

Making the Plant Safe. METROPOLITAN LIFE INSURANCE CO. Reviewed in *Brick Clay Rec.*, **77** [9], 485 (1930).—The current study discusses the need for adequately guarding certain types of machinery and certain operations, and relates some of the

fundamentals for instituting these safeguards and getting them used. Other sections of the study deal with the maintenance of guards, the machinery which should be protected, plant housekeeping, and the proper care of hand tools as a matter of accident prevention. E.J.V.

PATENT

Making a decolorizing clay. WALTER S. BAYLIS. U. S. 1,781,265, Nov. 11, 1930. The process which comprises treating an initial batch of an activatable colloidal clay with a highly-ionized mineral acid, adding a greater quantity of raw activatable clay, and subjecting the mixture to a temperature sufficient to eliminate substantially all water of crystallization and free acid from the clay.

Book Reviews

Introduction to Ceramic Industries. HIRENDRA NATH BOSE. Published by R. P. Mitra & Son, Calcutta, India, 1930. 305 pp. Rs. 4 (about $1.50). In this volume B. gives a broad outline of the different branches of the ceramic industries. Although intended mainly for a student in ceramics, the book contains considerable material of general interest for anyone engaged in ceramic work. He has blended well theory and practice, referring to a bibliography which precedes the text for a fuller account of the details. The book opens with a short history of ceramics, tracing the important developments from ancient Egyptian times to the present. Ceramic ware is classified and defined. The first chapter is devoted to the raw materials. The physical and chemical properties of kaolins, secondary clays, feldspars, quartz, flint, and plaster of Paris are discussed. Purification, washing, aging, and souring of clays are also taken up. The next chapter treats the different methods of formation and shaping and drying and scumming. In the chapters that follow the topics discussed are Porcelain; Stoneware; Earthenware; Terra Cotta; Fuels, Kilns, and Pyrometry; Ceramic Calculation; and Refractories. In the appendices at the end of the text are included the deposits of china clay in India; analyses of clays and other raw materials; conversion tables for fritted materials and some useful data. The book with its numerous illustrations is instructive to student and plant man alike. , ABDE ALLY

Glass, Its Preparation and Use. (Glas seine Herstellung und Verwendung.) F. H. ZSCHACKE. Theodor Steinkopff, Berlin and Dresden, 1930. 208 pp. 23 illustrations. Rm. 12.00. This book, addressed to industrialists and technicians, is a compilation of the newest researches on glass. Raw materials used in the manufacture of glass and their preparation, the properties of the glass batch in its working state, and the general physical and chemical properties of the materials used are given. The composition and properties of technical glass are described in a special chapter together with colored and opaque glass. The following points are discussed: (1) glass raw materials and methods for their research; (2) preparation and mixing of raw materials; (3) fusing glass; (4) glass in its working state; (5) cooling of glass; (6) thermal properties of glass; (7) properties of elasticity; (8) optical properties of glass; (9) electrical properties of glass; (10) behavior of glass toward gases and liquids; (11) chemical analyses of glass; (12) composition and properties of technical glass; (13) working of finished glass; (14) errors in glass; (15) crystallization and structure of silicates; (16) constitution of glasses; (17) machines used for working glass; and (18) kilns used in glass industry and their refractory materials. M. V. KONDOIDY

BLAZE A TRAIL

with

THE AMERICAN CERAMIC SOCIETY

at the

AMERICAN CERAMIC CONGRESS

Cleveland Auditorium

FEBRUARY 22-28, 1931

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Exchange your findings in scientific research

Exercise the joy of friendship with your fellow workers

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American Ceramic Congress

The Chicago World's Fair Ceramic Assn.
The American Refractories Institute
The National Brick Manufacturers Assn.
The Grinding Wheel Manufacturers Assn.
The Feldspar Grinders Institute
The American Ceramic Society

The above associations have arranged meetings to be held in Cleveland during the week of February 22-28, 1931.

A Ceramic Exposition of Ceramic products, materials, and equipment will be in place in the Cleveland Auditorium.

All meetings will be held in the Auditorium. A schedule of these with room assignments will be in the combined program book.

One and one-half round trip fare on certificate plan by all railroad Passenger Associations has been granted.

The resident hotel assignments are as follows:

American Refractories Institute National Brick Manufacturers Assn. Grinding Wheel Manufacturers Assn. Heavy Clay Products Division, American Ceramic Society Refractories Division, A.C.S.	**HOTEL CLEVELAND**
Art Division, A.C.S. Terra Cotta Division, A.C.S. White Wares Division, A.C.S. Chicago World's Fair Ceramic Assn.	**HOTEL STATLER**
Enamel Division, A.C.S. Glass Division, A.C.S. Materials & Equipment Division, A.C.S. Feldspar Grinder's Institute	**HOTEL HOLLENDEN**

CERAMIC

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Ceramic Educational Directory

THE OHIO STATE UNIVERSITY
Department of Ceramic Engineering, COLUMBUS, OHIO

Curriculum—Ceramic engineering and technology. Advanced research in coöperation with State owned plants and Federal Government

SIX INSTRUCTORS *Head of Department:* ARTHUR S. WATTS
Founded 1895 *Research Professor:* GEORGE A. BOLE

NEW YORK STATE SCHOOL OF CLAYWORKING AND CERAMICS
ALFRED UNIVERSITY, ALFRED, NEW YORK

Curriculum—Ceramic Engineering, Ceramic Chemistry, Appied Art

NINE INSTRUCTORS *Founded 1900* *Director:* CHARLES F. BINNS

RUTGERS UNIVERSITY
NEW BRUNSWICK, N. J.

Ceramic Department founded 1902
Curriculum—Ceramic Technology and Engineering

THREE INSTRUCTORS *Director:* GEORGE H. BROWN

UNIVERSITY OF ILLINOIS
Department of Ceramic Engineering *Founded 1905* URBANA, ILLINOIS

Curriculum—Ceramic Engineering and Ceramics, the latter is a non-engineering course in the technology of ceramic products

SIX INSTRUCTORS and a research associate *Head of Department:* C. W. PARMELEE

IOWA STATE COLLEGE
Department of Ceramic Engineering, AMES, IOWA

Curriculum—Ceramic Engineering major, Ceramic Technology and ornamental ceramics

FOUR INSTRUCTORS, TWO COURSES *Founded 1906* *Head of Department:* PAUL E. COX

THE UNIVERSITY OF NORTH DAKOTA
Department of Ceramics and Ceramic Engineering, GRAND FORKS, N. D.

Curriculum—Ceramic Art and Technology

FIVE INSTRUCTORS *Founded 1910* *Director:* A. W. GAUGER

UNIVERSITY OF WASHINGTON
Department of Ceramic Engineering, SEATTLE, WASHINGTON

Curriculum—General ceramic engineering with research in ceramics and non-metallics
Coöperation with the U S. Bureau of Mines

Director: HEWITT WILSON *Founded 1918* *Assistant:* J. H. YATES

UNIVERSITY OF SASKATCHEWAN
SASKATOON, SASK.

Curriculum—Ceramic Engineering

TWO INSTRUCTORS *Founded 1921* *Head of Department:* W. G. WORCESTER

PENNSYLVANIA STATE COLLEGE
Department of Ceramics, School of Mines and Metallurgy
STATE COLLEGE, PENNA.

Curriculum—Ceramic Engineering

Head of Department: J. B. SHAW *Founded 1923*

GEORGIA SCHOOL OF TECHNOLOGY
ATLANTA, GEORGIA

CERAMIC DEPARTMENT *Curriculum*—Ceramic Technology and Engineering
TWO INSTRUCTORS *Founded 1923* *Director:* A. V. HENRY

VIRGINIA POLYTECHNIC INSTITUTE
BLACKSBURG, VIRGINIA

Curriculum—Ceramic Engineering

Founded 1929 *Head of Department:* J. W. WHITTEMORE

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING
RALEIGH, NORTH CAROLINA

Department of Ceramic Engineering founded 1923 *Curriculum*—Ceramic Engineering
THREE INSTRUCTORS *Head of Department:* A. F. GREAVES-WALKER

WEST VIRGINIA UNIVERSITY
MORGANTOWN, W. VA.

Ceramic option course founded 1924

Curriculum—Chemical and engineering principles applies to ceramic manufacture

TWO INSTRUCTORS AND TWO ASSISTANTS *Director:* W. A. KOEHLER

UNIVERSITY OF TORONTO
TORONTO, CANADA

Founded University, 1827; Department of Metallurgy, Ceramic Division, 1925

Curriculum—Ceramic Engineering and Technology

TWO INSTRUCTORS *Principle Instructor:* ROBERT J. MONTGOMERY

MISSOURI SCHOOL OF MINES AND METALLURGY
OF THE UNIVERSITY OF MISSOURI, ROLLA, MO.

Cirriculum—Ceramic Technology and Ceramic Engineering

TWO INSTRUCTORS

Director: CHAS. H. FULTON *Founded 1926* *Head of Department:* M. E. HOLMES

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THE OHIO STATE UNIVERSITY
Department of Fine Arts, COLUMBUS, OHIO

Curriculum—Ceramic art and technology to train artists for the ceramic industries

THIRTEEN INSTRUCTORS *Head of Department:* JAMES R. HOPKINS

Founded 1927 *Professor of Ceramic Art:* ARTHUR E. BAGGS

UNIVERSITY OF OKLAHOMA
NORMAN, OKLAHOMA

Dept. of Ceramics, School of Fine Arts *Curriculum*—Ceramic Art

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UNIVERSITY, ALABAMA

Ceramic Option Course, Founded 1928

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TWO INSTRUCTORS *Director:* STEWART J. LLOYD *Ceramics:* T. N. MCVAY

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Director: THEODORE J. HOOVER *Founded 1925* *Professor in charge:* W. F. DIETRICH

OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE
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of the

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A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions, and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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EDITORIAL

PROGRESS COST

An educator yesterday reminded us that with the passing of each day, additions are being made to the sum total of our information. This is true for both the fundamental and applied knowledge.

With the increasing numbers of persons engaged in the search for the fundamental facts and in the application of these facts, the daily growth of available information is also accelerating. Increasing facilities for education, scientific researches, and applications connote increasing daily increments of knowledge; and knowledge is progress.

So rapidly has this knowledge increased that specialization in school curricula, in scientific research, and in making application of facts, has caused the focusing of individual attention to more and more limited fields of knowledge. The day is but a decade or two gone when a college instructor could successfully handle classes in science, mathematics, language, philosophy, and economics. The day is past when an instructor in Greek will become one of the world's greatest physicists as in the case of A. A. Michaelson.

The need for specialization cannot be sidestepped. One must evaluate

specialization from the present and the future, rather than from the past. Men are not made famous for their works because of their broad cultural foundation, but because they have focused their work on that for which they have the greatest talent.

It requires but little looking about to realize that the managing owner is no longer qualified to tend personally to all details of production, sales, and financing. The larger the plant the more need there is for having specialists in charge of each department.

The day has gone when a person can alone keep apace with the world's accelerating daily speed in knowledge increase. Gradually each one finds the specialty that fits his talents and forsaking all others, keeps this specialty alone unto himself. And even in each of the narrowing special lines of human endeavor, the daily increase is too widespread in source and in fact for any person by his lone effort to keep up with it.

The need for collective efforts became apparent many decades ago; first, in the highly specialized scientific fields and now in most all lines of human activities. Thus began and thus multiplied associations and societies. They were inevitable, and especially so today when specialized industries, arts, and sciences are no longer centered geographically, but are spreading to all continents, to all nations, and to all parts of each nation.

Pittsburgh for steel, Akron for rubber, Trenton for pottery, and Lowell for textile are rapidly losing these distinctions. Increasing means of transportation and communication are partly responsible for this change but these are not as responsible as is the ever-increasing spread of specialized knowledge. If one would keep up with experts in his line, he must have available the daily increments of knowledge in his special work as they are made the world over.

Obviously there is a need for organizations of experts with facilities to make current collections and to publish periodically this information from all parts of the world. This is the reason your AMERICAN CERAMIC SOCIETY is functioning and the reason the SOCIETY is divided into Industrial Divisions. The more facilities you give to your SOCIETY the more certainly will it grow from day to day in pace with the ever-increasing fund of ceramic information the world over. This is the price of progress.

PAPERS AND DISCUSSIONS

HISTORY OF STRASBURG FIREBRICK DISTRICT[1]

By E. J. Bognar

The well-known Strasburg District which produces approximately 72,000,000 nine-inch firebrick equivalents per year is one of the most outstanding firebrick districts in the United States and perhaps the largest producer of the so-called intermediate-duty or second-quality refractory.

Due to the proximity of the district to the steel belt and the low price at which the brick sells, it has played an important rôle in the development of the iron and steel industry.

The entire district operates in the lower Kittanning clay, or No. 5. This industry developed and prospered at this particular place because it is the only spot in Ohio where the Lower Kittanning plastic contains flint clay of commercial value. As a matter of fact, a small area near Hammond, W. Va., is the only other place where a similar instance is recorded.

The Strasburg flint-bearing area is only eighteen and one-half miles long and three miles at its widest point. The deposit runs essentially east and west. Its axis, determined from all known deposits, is about 10° north of east.

According to Wilber Stout, State Geologist, a detailed section taken at the open pit of the Corundite Refractories, Imperial Plant, Zoar, Ohio, on October 5, 1929, reads as follows:

	Ft.	In.
Coal, fair quality, Lower Kittanning	1	6
Clay, plastic, light, siliceous with some shot	5	1
Clay, plastic, dark, good		7
Clay, plastic, soft, good		1½
Clay, soft coaly, quite pure		⅓
Clay, plastic, dark gray, excellent	2	7½
Clay, flint, irregular, nodular in character, high grade	1	5½
Clay, plastic, light, very fine		8½
Clay, plastic, dark, good		10½

Figure 1 gives a good conception of the known area in which scattered and commonly disconnected patches of flint occur. The writer estimates that the actual flint in this area of forty-four square miles will not exceed eight square miles. Streams that formed rivers and wide valleys have cut away much of the land. As a result, probably less than one-third of the original flint clay remains. The flint clay varies from a mere trace to nine feet in thickness, and three feet is a fair average of the usual measurement.

The plastic clay will vary from ten to twenty feet, while twelve feet might be considered as an average thickness. This thickness includes any flint that may be present which, if existing, is to be found in the upper half of the plastic.

[1] Received June 4, 1930.

A typical analysis of the Lower Kittanning plastic clay taken from the pit of the Corundite Refractories, Inc., at Zoar, Ohio, Tuscarawas County, reads as follows:

CHEMICAL ANALYSIS

Loss at 105°C	2.31
Ignition loss	7.95
Silica	57.81
Ferric oxide	2.84
Lime	0.52
Magnesia	0.30
Titanic oxide	1.56
Phosphorus pentoxide	0.11
Sodium oxide	0.13
Potassium oxide	2.26
Manganous oxide	0.02
Sulphur	0.52
Alumina	24.81
Total carbon	0.16
Inorganic carbon, C	0.08

PHYSICAL TESTS

Working properties: very smooth, fine-grained, plastic, molds well

Tempering water	17.26%
Drying linear shrinkage	5.58
Drying volume shrinkage	17.69

Firing	Temperature	Linear shrinkage (%)	Volume shrinkage (%)	Volume absorption (%)	Color
Cone	010	1.53	4.51	21.20	Light buff
"	03	3.19	9.28	18.64	Medium buff
"	3	4.09	11.78	16.86	Dark buff
"	5	5.83	16.49	9.46	Dark buff
"	6	4.81	13.74	4.06	Gray speckled
"	9	2.95	8.58	1.69	Brown gray speckled
"	10	2.72	7.94	2.45	" " "
"	12			1.90	" " "
"	14			1.83	" speckled

The following is an analysis of the Lower Kittanning flint clay from the pit of the Corundite Refractories, Inc., Zoar, Ohio, Tuscarawas County.

ANALYSIS

Silica	47.93%
Alumina	33.70
Iron oxide	1.93
Lime	0.63
Magnesia	0.38
Titanium oxide	2.17
Alkalis	0.09
Ignition loss	12.89
Total	99.72%

Total linear shrinkage at cone 13 is 3.5%
Pyrometric cone equivalent: cone 33

Some of the flint in this field is of inferior quality, containing such impurities as sand, iron carbonate, and pyrite. The best flint has a total shrinkage of from 3 to 4% when fired to cone 13, while some which is really a semiflint shrinks as much as 9.5% when fired to the same temperature. The best flint has a P.C.E. of Orton cone 33, or 3128°F.

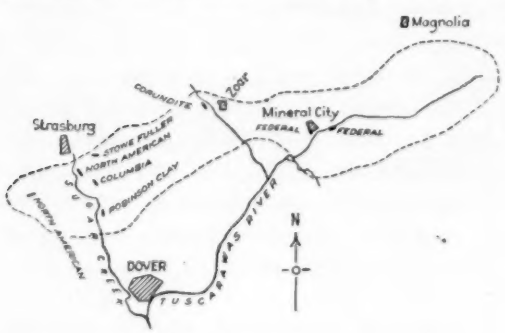

FIG. 1.

The plastic is of the average Kittanning quality as found in Ohio, although in places it is of such quality that it reaches a P.C.E. value of cone 26, or 2912°F.

In general, three grades of refractories are made in this district by the

various manufacturers, and although each plant has its specific name, the brick may roughly be classified as follows:

	Approximate Mix	
First grade, cone 30	75 flint	25 plastic
Second grade, cone 28	50 "	50 "
Third grade, cones 23–26	25 "	75 "

By far the greatest percentage of the brick produced is made by the dry-press process. About the only brick made by hand are those shapes which so far no one has successfully made on a dry press. One or two plants, however, still produce a limited amount of soft-mud brick.

The following is a list of the plants of the Strasburg District, and their annual firebrick production, figured in 9-in. equivalents, when operating at capacity. Estimates given were received from operating heads of various companies.

Stowe-Fuller Refractories Co.	12,000,000
Robinson Clay Products Co.	12,000,000
North American Refractories Co., Plant No. 1 and Plant No. 2	20,000,000
Columbia Fire Brick Co.	15,000,000
Corundite Refractories, Inc.	6,500,000
Federal Clay Products Co.	6,500,000
	72,000,000

It is interesting to note that this entire district with a total of eight plants and an annual production of 72,000,000 brick fires the entire amount in round downdraft kilns. Not a single tunnel kiln is in use here.

For much of the following history the writer is deeply indebted to Thomas Kemp, Sr.,[2] of Dover, Ohio, and George Markley[3] of Mineral City. Both have spent more than fifty years in the firebrick business of this district, and may rightly be considered as having contributed much to its development.

In 1867, the first firebrick plant of the Strasburg District was started by Rhodes and Card of Cleveland, Ohio, and David Miller and Henry Hariff of Dover, Ohio. This plant was located between what is now the fair grounds and the American Rolling Mills. There is at this writing a gasoline station on the exact location.

Early in the same year these men started a blast furnace in Dover, and relied upon the local kidney and black band ores to keep their furnaces in operation. While digging for these ores northeast of town, near Zoar, they discovered fire clay of the plastic and flint varieties. This discovery encouraged them to build the Dover brickyard.

The clay was hauled a distance of four or five miles to Zoarville where it was loaded in cars and transported by rail to Dover. All kinds of brick

[2] Thomas Kemp is general manager and vice-president of the Stowe-Fuller Refractories Co., Cleveland, O.

[3] Geo. Markley is president of the Federal Clay Products Co., Mineral City, Ohio.

and shapes were made, and the product shipped everywhere. The greater percentage, we are told, went to the steel mills in the Mahoning Valley. The old Glasgow, Port Washington Coal and Iron Company was built entirely of Dover brick.

In 1872, the Dover Fire Brick Plant changed ownership, passing into the possession of Colonel Barrett of Cleveland, who controlled the plant until his death in 1918.

In 1864, C. Edward Holden of New York City, while passing with a surveying party near Mineral (now Mineral City) discovered flint clay and plastic. Sensing the importance of his find, he acquired several hundred acres of land and erected a firebrick plant in the center of the town of Mineral. The exact date is in dispute, and some would have it that the founding was prior to 1867. It is certain, however, that his plant was in operation that same year. This plant still stands and is part of the Federal Clay Products Company.

Mr. Holden started out making about 3000 handmade brick per day of the variety this clay would make. Before very long he specialized in glasshouse refractories and for a long time had the reputation of making some of the best ware of this kind. The local flint clay was calcined and hand sorted to eliminate iron specks. For bond, various German pot clays were imported.

In 1911, Mr. Holden sold out to Mr. Markley, who still operates one firebrick plant in this district.

The retirement of Mr. Holden marked the rapid decline of the glasshouse refractory ware. Today very little work is done of this kind in the Strasburg area.

In 1883, T. Kemp built the Wentz-Wagner Company, on what is known as the Samuel Swaby farm. Then in 1884, the Dover Fire Brick Company abandoned its plant, and built a plant one mile south of Strasburg. This is now the North American Refractories Co., Dover Plant, No. 1.

In 1887, what is now known as the No. 1 Plant of the Federal Clay Products was built by Mr. Holden. Soon after its commencement, a stiff-mud machine and repress were introduced and this plant still operates successfully and continues to turn out stiff-mud brick. Incidentally, the clay is still obtained out of the same mine opened forty years ago.

In 1889, the Wentz-Wagner Company was sold to the Robinson Brothers of Akron, Ohio. This company is now known as the Robinson Clay Products Co., of Akron, Ohio. Shortly after they purchased this plant they built a sewerpipe factory in connection with the firebrick plant.

In 1889, a corporation was formed under the name of the Stowe-Fuller Refractories Company. That company built a plant one and one-half miles southeast of Strasburg, known as the National Plant. In 1910, another company was formed, known as the Columbia Fire Brick Com-

pany, who erected a plant two miles south of Strasburg. A few years later the Harbison-Walker Refractories Company of Pittsburgh constructed a plant a short distance north of Strasburg, and called the place Harwalk. This plant was equipped with a tunnel kiln, but after several months experimental work the whole plant was dismantled.

In 1913, the Zoar Fire Clay Company was organized. Its main object was to grind clay. Some years later this plant changed ownership and was incorporated as the Imperial Fire Brick Company of Dover. In the fall of 1929, the Corundite Refractories, Inc., of Pittsburgh acquired the plant.

About 1918, the Dover Fire Brick Company erected a plant two miles southwest of Strasburg. This is now Dover Plant No. 2 of the North American Refractories Company.

There is much plastic clay still available in this territory, but the known areas of the flint clay have long since been owned or leased by firebrick plants operating in the district.

The greatest percentage of the output of this area goes to the steel mills where it is used as a refractory in hardening, carburizing, normalizing, tempering, annealing, and similar types of furnaces.

It is also used extensively for flue and stack construction, as well as a lining in gas producers, low-duty boilers, cupolas, and kiln construction. A large percentage is also used for backing-up purposes and general utility work.

Without a doubt this district plays an important part in supplying the refractory needs of the many industries of the United States. When the flint clay of this area is exhausted a serious blow will have been dealt the steel industry. This should not happen for some years to come as there are several thousand acres of good flint left with an estimated average thickness of two feet.

A conservative estimate shows that only eight to ten acres of clay are used per year to produce 72 million nine-inch equivalents. Another good feature is that most of the clay is won by stripping, which means that practically all of the clay is used, whereas, in so many of the other fields where underground mining is employed, from one-half to two-thirds of the clay is left in the ground.

CORUNDITE REFRACTORIES, INC.
MASSILLON, OHIO

DISCUSSION ON "THE CAUSES AND PREVENTION OF BULGING IN HAND-MOLDED REFRACTORY SHAPES"[1]

By Josef Robitschek

In his thesis, part of which has been published under the above heading in the *Journal*, Richardson has covered the scope of an interesting subject quite thoroughly. There is, however, one point of great importance which has not been mentioned.

The primary cause of bulging is, as the author states, the bad structure of the "cut face" of the block, which is on top while the block is molded. This face is not so compact and dense as the opposite bottom of the block and this structural difference causes the trouble. If, therefore, in molding the block care would be taken to eliminate this difference, bulging could be reduced to a very slight extent.

In most of our European factories, especially in Czechoslovakian and German firebrick plants, great refractory shapes which are apt to cause such trouble are molded by hand in the following manner:

A large wad of clay of the size of the mold, which has been rolled in grog, is thrown with force in the sanded or greased mold. The mold is tamped on the molding table and the excess clay is cut off with a wire. Then the mold is turned so that the cut side is down. In this position the mold is tamped again. By this second tamping the cut side becomes as dense and compact as the opposite side of the refractory shape. After tamping, the mold is turned again, the surface smoothed, and the block removed from the mold.

Thus both faces of the block have approximately the same pressure during molding and the primary cause of bulging, that is, unequal structure of these faces, has been eliminated.

Refractory shapes which are molded in this way never bulge badly, even if they are set in the kiln before they have been completely dried. Of course, good technique and long practice is necessary for molding complicated heavy shapes. Tamping can be done by one man only if the weight of the shape does not exceed 40 to 50 pounds; otherwise two men must work together on one mold. Still wages for molding blocks from one bat with two men are lower than for molding the shapes in sections and the results are much better. Blocks of more than 120 or 130 pounds cannot be molded in this manner.

As stated above, Richardson thoroughly covered the scope of his subject. All the precautions which he proposes for the prevention of bulging are necessary to produce a good product; still there is only one way which eliminates the real cause of bulging in hand-molded fireclay shapes and

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[1] Discussion on paper by Gordon Richardson, *Jour. Amer. Ceram. Soc.*, **13** [4], 256–71 (1930).

that is production of even structure on both sides of the shape by tamping it on both sides. Therefore complete or almost complete elimination of bulging may be possible only by using the molding process described above.

FIREBRICK AND STONEWARE PLANT
MONTAN- UND INDUSTRIALWERKE VORM. J. D. STARCK
BRASY, CZECHOSLOVAKIA

DISCUSSION ON "STIFF-MUD DIE TROUBLES"[1]

BY R. H. ELLIS-ANWYL

I have had some experience in the preheating of clay for use in manufacturing hollow building tile and this is a satisfactory method for reducing lamination provided constant moisture control is obtained.

It has also been found that a 10 to 20° bushing in the back of the die aids in curing lamination and irregular flow of the clay through the die.

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[1] Ellis Lovejoy and H. B. Henderson, *Jour. Amer. Ceram. Soc.*, **13** [11], 787–93 (1930).

ACTIVITIES OF THE SOCIETY

PUBLICITY PLANS FOR THE AMERICAN CERAMIC EXPOSITION

Store Coöperation.—These leading stores of Cleveland, Halle Brothers Co., Higbee Company, Sterling and Welch, Kinney and Levan, Wm. Taylor Sons Co., and the May Company have definitely promised coöperation during the week of the Exposition and before. This coöperation is to include first, enclosing in their February bills a card of invitation to attend the Exposition; second, featuring American-made ceramic products in their newspaper advertising prior to and during the show; third, maintaining a window display of ceramic products during the week of the show; and fourth, endeavoring by personal solicitation to attract their customers to the auditorium during the week of February 23. All of these stores, with the exception of Halle Brothers, have likewise agreed to exhibit art posters advertising the Exposition. Halle Brothers, moreover, have agreed to take a speaker on some ceramic subject, the speaker to talk in the Halle auditorium, the publicity to be furnished by the store.

This is an outline of what has already been accomplished with the stores. What remains to be done is merely to supply them with cards of invitation and to see that the program is carried out.

Ceramic Speakers.—It was originally mentioned as part of the publicity program that an effort be made to arrange for talks before a number of representative organizations on some matters relating to the ceramic industry. Three talks have been arranged. As mentioned above, Halle Brothers will take a speaker. The Women's City Club will be glad to have another, preferably R. G. Cowan. The Home in the Sky which is sponsored by the Builders Exchange would like a third and there is a possibility that this last engagement will be broadcast as well as treated as an ordinary speech. All of these talks are to be nontechnical and nonselling and should feature the artistic side of the ceramic industry, either as applied to the industry itself or to the use of ceramic products in the home. Inasmuch as practically all of the persons who will hear these talks will be women, speakers must be chosen who will be likely to attract them.

Contests.—It was suggested in the original program of publicity that contests be run in the public and parochial schools. Miss Ruth Fliedner of the Board of Education, who is in charge of art in the schools, has sanctioned two contests for the Cleveland public schools. The senior high schools, of which there are thirteen, will have a contest on the design of whiteware. The entries are to be submitted in the form of colored sketches and will be judged by a committee to be appointed later. The junior high schools will have a contest on the design and manufacture of some form of art pottery, the entries in this case to be a completed small bowl which may be used for flowers, as an ash-tray, and the like. The newspapers of Cleveland have arranged to make mention of this contest, but it will not be run under the sponsorship of any one newspaper.

What remains to be done in regard to the contests, includes discussing and deciding the prizes. It was tentatively decided at an earlier meeting of the Cleveland executive committee that the prize winner in the whiteware contest should have his suggestion made up, the winner to receive one set and the other set to be sold through the recognized agencies. Cash prizes, however, are essential and Miss Fliedner says that while each contest may be run for as little as $100.00 in total prizes, she suggests $150.00 to $200.00 for each division. She also believes that it will be almost essential to have some sort of an exhibition in each of the senior high schools and suggests a number of dinner plates illustrating various steps in their manufacture. This would require thirteen different sets, each showing a finished plate and the plate as it appears in every

previous step of manufacture. Judges must be appointed for this contest and these will undoubtedly consist of members of the school board and from the ceramic industries.

Display.—The Home in the Sky has offered the use of one of its display sections before and during the Exposition at the Public Auditorium. This display is to consist of essentially the same thing as the display for each of the high schools, but is to include also a number of fine pieces both of art ware and tableware. The Women's City Club is also allowing us to use its display case to show a number of beautiful pieces in the finished form.

Very truly yours,

JOHN G. MAPES

EXPOSITION DETAILS AND INFORMATION FOR EXHIBITORS AT AMERICAN CERAMIC EXPOSITION

Bulletin No. 1: Shipping Instructions

Time of Arrival.—Material should be shipped so as to arrive at Cleveland by February 19.

Cartage Rates.—The management of the Exposition has contracted with the Norris Brothers Company, 2138 Davenport Avenue, Cleveland, Ohio, to handle all exhibit material from railroad terminals to the Public Auditorium and to deliver same to the various spaces promptly and in good order, and at the close of the Exposition to remove all exhibit material and reship same after it has been properly crated. The following are the cartage rates:

Shipments under 150 lbs.	$1.00
Shipments 150 lbs. to 1000 lbs.	2.50
Shipments over 1000 lbs.	5.00 per ton

The same rates will apply on the outgoing shipments as on the incoming.

Labor will be supplied where needed by the cartage firm for uncrating, skidding, and erecting exhibit materials as well as recrating and reskidding at the following rates:

Foreman	$1.50 per hr.
Riggers	1.25 per hr.
Night and Sunday work	Double time

Common labor supplied by the Public Auditorium at the standard rate per hour.

Consignment of Material.—All carload shipments made over any railroad should be consigned to:

Exhibitor's Name_____
Booth No._____
C/o Norris Brothers Co.
Penna. R. R. Auditorium Siding
Cleveland, Ohio
For American Ceramic Exposition

The Auditorium siding is served by the Pennsylvania railroad, and in order to have freight cars placed on the siding they should be routed c/o Penna. R. R. as indicated above.

Less than Carload Shipments.—L. C. L. shipments or less than carload lots over any railroad should be marked as follows:

Exhibitor's Name_____
Booth No._____
C/o Norris Brothers Co.
2138–2144 Davenport Avenue
Cleveland, Ohio
For American Ceramic Exposition

Shipments consigned otherwise are likely to go astray. Please make your shipments early and prepay all freight.

Bill of Lading.—As soon as shipments are made, exhibitors should forward original bills of lading promptly to Norris Brothers Company, 2138 Davenport Avenue, Cleveland, Ohio, so that they may be in constant touch with all shipments and have time to trace if necessary.

Storage Accommodations.—The Norris Brothers Company will accommodate early shipments in their warehouse at no charge and in the event that exhibitors wish to place exhibit material in storage after the Exposition, the Norris Brothers Company will store this in their warehouse for a period of sixty days at no cost.

Express Shipments.—Express shipments must be prepaid. Shipments addressed to yourself, care of Public Auditorium, will be delivered to your space by the Express Company at no extra charge. Address material as follows:

Your Firm_____
C/o American Ceramic Exposition
Cleveland Public Auditorium
Cleveland, Ohio
Booth No._____

To be assured of prompt delivery of your exhibit material, please follow the above instructions.

Bulletin No. 2: Wording for Booth Signs

You will be furnished free, a two-line booth sign to be erected in the back center of your booth. This sign is $9^1/_2$ x 72 in. If you desire your trade name or any special wording or colors, this will be charged extra at the time necessary to do the work.

Bulletin No. 3: What You Will Exhibit and Who Will Be in Attendance

This information is desired for publication in the official program and should be made as complete as possible and returned immediately in order that you may receive this additional publicity: This information, if containing news of something novel or unusual will be used by the Publicity Department and will be given general distribution throughout the trade.

Bulletin No. 4: Furniture

The Exposition Service Company, Inc., 825 South Wabash Avenue, Chicago, Ill., has a warehouse in Cleveland, and the management of the Exposition has arranged with this Company to supply furniture for the Exposition.

The following gives a list of the furniture available and prices. It is our suggestion that you select the furniture that you need and send your order to Exposition Service Company, Inc., 825 South Wabash Avenue, Chicago, Ill.

Furniture Available and Rental Prices

Oak or Mahogany			
36 in. flat top desk	$ 4.50	24 in. round wicker table	$ 2.50
50 in. " " "	7.00	42 x 22 in. wicker table	6.00
60 in. " " "	10.00	54 x 18 in. wicker table	7.00
Arm chairs	1.75	Floor lamps (wrought iron,	
Arm swivel chairs	2.00	with shades)	5.00
Straight chairs	1.00	3-foot display table	1.50
Costumers	1.50	4-foot " "	2.00
Typewriter desks, 36 in.	8.00	5-foot " "	2.50
Cuspidors	1.00	6-foot " "	3.00
Waste baskets (green steel)	0.50		

Upholstered Wicker Furniture (Pea Green Colored Upholstery)	
Table lamps	3.00
Upholstered arm chairs	4.00
" 4-ft. settee	10.00
" 6-ft. "	12.00

Special Furniture	
Fancy high back carved upholstered chairs	10.00
16 in. x 16 in. polished table	1.50
36 in. x 24 in. " "	2.50
48 in. x 28 in. " "	3.50
60 in. x 28 in. " "	5.00
72 in. x 28 in. " "	6.00
36 in. x 22 in. wicker "	4.00

Rugs (Wilton Velvet)	
36 in. x 63 in.	1.50
6 ft. x 9 ft.	5.40
8 ft. 3 in. x 10 ft. 6 in.	8.00
9 ft. x 12 ft.	10.80

Grass or Crex	
6 ft. x 9 ft.	3.00
9 ft. x 12 ft.	5.00

Bulletin No. 5: Tie-In of Advertising

As an exhibitor you are interested in securing as much publicity for your exhibit as possible. It is suggested that you carry in all of your advertising a notation as suggested below, inviting people to attend the Exposition and visit your booth.

So that your display will receive as much publicity as possible, it is suggested that you drop a line to all publications carrying your advertisement requesting them to insert the following line in your advertisement from now until the Exposition:

"See our exhibit at American Ceramic Exposition
Cleveland
February 23–27, 1931"

Bulletin No. 6: Special Displays

We have completed negotiations with State Display, 1135 Superior Avenue, Cleveland, Ohio, to be official designers and builders of special exhibits and backgrounds for those who wish to avail themselves of this service. You will receive a communication from them.

Bulletin No. 7: Miscellaneous Services

Electricity.—A reasonable charge will be made by the Auditorium for any electrical hook-up and current required by the exhibitors such as additional lights in the booths, motors, etc.

There is available:

220 and 110 volt, single phase, A.C.
220 volt, 3 phase, A.C.
220 and 110 volt, D.C.

Air, Water, and Drain.—Services such as compressed air, water, drains, carpenter work, etc., can be secured through the management of the Cleveland Public Auditorium. Prices for these various services will be quoted by the Auditorium upon request.

Photographs.—W. H. Figary & Company will have a representative at the Exposition to take photographs of booth equipment display, etc., at the following prices:

Four prints and one negative, 8 x 10	$5.00
Extra prints	0.50 each
Or 30¢ each for dozen lots	

Complimentary Tickets.—Within a short time each exhibitor will be forwarded a supply of free admission tickets. These tickets are being printed at no cost to you

with the name of your firm printed on each ticket. They will be mailed to you under separate cover within a reasonable time.

The tickets should be distributed to your customers and prospective customers so that they may attend the Exposition and visit your exhibit.

THE CHICAGO WORLD'S FAIR CENTENNIAL CELEBRATION, 1933

The ceramic industries, including the clay, glass, and porcelain enamels must set up a general exhibit showing "A Century of Progress." This general exhibit will be the central feature in the portion of the Minerals Building devoted to ceramics. Surrounding this central exhibit, showing a century of progress in ceramics, will be booths which the Exposition Commission will rent to private concerns for private exhibits.

We are concerned only with the general exhibit showing the century of progress in ceramics. There will be no charge for this space, but the character of the exhibit rests with the ceramic industries to determine.

Nearly all of the other industrial groups have accepted this assignment from the Chicago World's Fair Commission, and some of them have extensive plans already decided upon which will show the progress made within their industry, and the contributions made by their particular industry to progress in science and technology generally. Some of the groups have planned to spend as high as $500,000 on their central exhibit.

The AMERICAN CERAMIC SOCIETY, being the technical and scientific organization representative of all the ceramic groups, has been asked to initiate the organization of the ceramic industries, the task of which will be to design and set up this general exhibit. One of the first tasks will be to inform the Chicago Fair Commission what space will be required, and come to an agreement regarding the character of the exhibit.

For the purpose of organizing a Chicago Centennial Ceramic Exposition, we have called for a meeting of leaders in the several ceramic industries to be held in the Stevens Hotel, West Ball Room, 10 A.M., Thursday, January 8.

This matter is of great importance because the ceramic industries cannot afford to be without adequate representation in this great Fair. We must make haste, because plans and construction of the Exposition are going forward rapidly. Two of the buildings are already constructed.

We shall appreciate very much if you will attend or designate a delegate to attend this meeting on January 8, empowered to collaborate in making plans for an extensive central ceramic exhibit.

Yours truly,
EDWARD ORTON, JR., *President*
AMERICAN CERAMIC SOCIETY

BILL IN CONGRESS FOR COPYRIGHT REVISION

Your Support Is Desired

The Author's League of America
2 East 23rd St.
New York, N. Y.
December 9, 1930

Dear Mr. Purdy:

I am writing to ask the active help of the AMERICAN CERAMIC SOCIETY on the Vestal Bill for General Copyright Revision for which all who are affected directly or indirectly by copyright must fight for attention and passage in the present short session of Congress.

The present copyright law, enacted in 1909, is inadequate and outmoded by modern trade practices. It is only by the passage of the copyright revision bill (introduced by Hon. Albert H. Vestal in the House last spring and carried over into the final session of Congress) that a much needed reform of the copyright law can take place.

The main reforms are:

(1) *Automatic Copyright:* Without formality, the author upon completion of his creative work establishes ownership of copyright.

(2) *Divisible Copyright:* The author or other owner of copyright is given clear legal title to separate rights within his copyright privilege (magazine, book, motion-picture rights, etc.)

(3) *Extension of Term of Copyright:* From 56 years after publication to the life of the author and fifty years after his death, in conformity with general practice throughout the world. (This is designed to protect the author and his heirs.)

(4) *International Copyright:* Through adherence of the U.S. to the Berne Convention, American authors will be able to secure automatic copyright without formality throughout the 40 member countries of the International Copyright Union. If the U.S. fails to enter the Union by August 1, 1931, American authors and industries arising out of copyright (newspapers, book and magazine publishers, motion pictures, the theater, etc.) will have little, if any, protection of their work abroad, as our provisional copyright agreement terminates at that date.

Under the General Copyright Revision Bill, copyright for works of art may be secured, and reproductions of a work of art, including engravings, lithographs, photogravures, casts, plastic works, or copies by any other means of reproduction. This should be of prime interest to your members. Also, we believe that the passage of this Bill affects some, if not many, of your members who contribute articles either to your own periodical, or to those dedicated to your profession, or who may be authors of copyrighted books. We further believe that endorsement of the Vestal Bill for General Copyright Revision by the AMERICAN CERAMIC SOCIETY and personal endorsement to Hon. Albert H. Vestal (House Office Bldg., Washington, D. C.), and to their own Congressmen by your members urging support and passage of the Bill, will aid its passage in the short session. The Bill has been approved by the many varied groups closely connected with copyright.

Very truly yours,
CHARLES PURDY
for the Copyright Committee

SUMMER MEETING OF AMERICAN GLASS TECHNOLOGISTS[1]

BY F. W. PRESTON

A cool wind and a cloudless sky, the swish of waves on a sandy shore, and log fires in the evening provided the setting for the summer meeting of the Glass Division of the AMERICAN CERAMIC SOCIETY at Cove Point, Maryland, the first week-end in October.

Bald eagles, turkey buzzards, black snakes, and other desirable creatures helped to provide local color, while the menu included incredible numbers of deviled crabs and bedeviled oysters.

The meeting place was the same as last year, the seaside estate of Flint (Hazel-Atlas) and Merritt and Peters (Bureau of Standards), but the gathering was three or four times as large, running over the 40 mark for part of the time.

Merritt was generally to be found several miles out at sea, his little white leg-of-mutton sail against the eastern horizon. Generally he had some of the rest with him, but in any case he was hardly to be cajoled ashore, but stayed afar off as in his boyhood days off the coast of Hawaii.

Two business sessions were held, one on Saturday and one on Sunday. At the first, the main themes concerned organization. Sam Scholes delivered an ultimatum about papers for February and considerable debate took place on this subject. There was no

[1] Reprinted from *The Glass Industry*, **11** [11], 252–54 (1930).

unanimity as to what form the meetings in February should take and it was finally decided that everybody should write to Scholes asking for what he (the writer) wanted and saying what he himself would do toward getting it. So don't forget to write to him—at Fostoria Glass, Moundsville, W. Va.

Courtesy of Glass Industry

FIG. 1.—Local color. The cook's factotum. Hettinger paid him 5¢ per meal to see that his tumbler was always full of water.

Specific suggestions by the Education Committee of the Society, as to the allocation of time by undergraduates in Ceramics to fundamental science, cultural subjects, and business matters, were discussed at length. The general sentiment was that undergraduates should devote themselves to such matters to the almost complete exclusion of strictly ceramic affairs, at least so far as glass technologists were concerned. A narrow specialization in undergraduate days was not desirable. The section was more favorable to a research course or post-graduate course in glass technology than to undergraduate work therein. The debate lasted a long time and was finally concluded by accepting a resolution brought forward by L. T. Sherwood, of which more may be heard later.

A proposal of the I. C. S. to establish correspondence courses in glass technology, if provided with help and suggestions by the SOCIETY, was considered, but it did not seem practicable to make any proposal in the absence of anyone who was competent and willing to organize such a course.

A proposal, now new, but discussed in Toronto last February, for organizing the work of the section through a permanent secretary, more particularly for ensuring continuity of policy and assisting universities and to some extent firms, in choosing subjects within the glass field for research, was favorably considered by the meeting. It was heartily endorsed by Ross Purdy as likely to assist editorial work by assessing the merits of papers and seeing to their form of presentation. The business men present considered that the funds could be raised readily enough to ensure the scheme being run for five years, starting early next year. The manner of organizing the work would have to depend greatly on the character and personality of the secretary.

Courtesy of Glass Industry

FIG. 2.—Dr. Schott of Jena, fifth from left, standing.

At the Sunday meeting a letter was read from Professor Turner of Sheffield on a recent editorial in *The Glass Industry*, and the meeting asked that steps be taken to

acquire as quickly as possible, biographies of the recently deceased inventors of the industry. Roy Blunt was delegated to obtain a biography of Michael Owens and several others are also in prospect.

Professor Turner's letter was given to George Morey for Dr. Day, for the purpose of canvassing in Washington the idea of an Industrial History Society.

The meeting passed a resolution congratulating Professor Turner on his recovery and expressing its pleasure in hearing that he was back at work.

The principal business of the Sunday meeting, however, was to hear an oration by George Morey on the constitution of glass. The meeting was glad to learn that the properties of glass cannot be changed by calling it a fourth state of matter or a colloid. There appeared to be no objection to calling it a fourth state, except that it did not help, but it was not a colloid, though in some cases it was headed that way. Further, no agreement was reached as to whether it was really solid, plastic, or viscous and finally, experiments to be carried out by C. D. Spencer over the next year or so, supplementing his previous observations (reported recently in *Nature*) were devised by the meeting in the hopes of settling the point.

Some considerable discussion centered on the equilibrium of the iron oxides in glass, in which Dr. Hostetter and Dr. Morey contributed some useful ideas. Another debate raged around the question of the annealing of glass, the essence of the matter being that Dr. Scholes considered the physics thereof very simple, while Mr. Begeman considered the engineering end of it anything but simple. The questions of annealing and of heterogeneity in glass were considered good subjects for papers at Cleveland next February, but most of the delegates were more anxious to listen than to orate on the subject.

Dr. Schott gave an account of some of his own experiences on a number of points raised and it is to be hoped that he will follow it up by writing a résumé of them.

A number of delegates visited the lighthouse to see the French lenses and were puzzled to know they had to be protected from sunlight.

J. T. Littleton, with uncanny instinct, discovered the only persimmon tree within miles, ate the ripe fruit with great relish and offered green ones to the unwary. His exploits in standing on his head in the Bay were matched by Aaron Lyle on dry land. Cutting capers in a speed boat alternated with radio reports on the progress of the World Series, while those who did not care to tear their pants in hunting spleenworts, orchids, and black snakes, found diversion in pitching quoits and horseshoes. In this, Arthur Kimes and C. D. Spencer, among others, proved strangely skilful. Others played baseball or shot at old shoes in the air with a .410 shot gun.

Courtesy of Glass Industry

FIG. 3.—At Cove Point lighthouse. How many can you identify?

Ross Purdy and one other went to church; they needed it.

LOCAL SECTION MEETINGS

California Section

The regular quarterly meeting of the California Section was held on December 8, 1930, at the Engineers' Club, Los Angeles, Calif. Fifty members were present.

The papers presented following the dinner were as follows:

"The Ultimate Aim of Ceramics" by Cecil Jones.
"The Work Being Done in Ceramics at Lincoln High School" by Frank Baddeley.
"Tunnel Kilns and Their Present Day Application" by W. H. Schotts.

NEW MEMBERS RECEIVED

CORPORATION

Pacific Stoneware Co., Inc., Thomas W. Mann (voter), P. O. Box 130, Kenton Station, 1945 Peninsular Ave., Portland, Ore.

PERSONAL

J. W. Akam, Aldershot, Ontario; Plant Superintendent, National Fire Proofing Co. of Canada, Ltd.
John H. Baxter, Sales Manager, Inland Gas Corp., Ashland, Ky.
Authur Bevan, State Geologist, Box 329, University, Va.
Charles E. Golding, Box 320, Trenton, N. J.; President, Golding-Keene Co., Standard Flint & Spar Corp., Southern Feldspar, Inc.
E. R. Hershey, Superintendent, Mansfield Vitreous Enamel Co., Mansfield, Ohio.
John Klumpp, Jr., 9th & J, Elwood, Ind.; Works Manager, Macbeth-Evans Glass Co.
Glen Lukens, Department of Art, High School, Fullerton, Calif.
H. B. McKee, Wellsville Fire Brick Co., Wellsville, Mo.
Edgar B. Read, Industrial Fellow, 412 Mellon Institute, Pittsburgh, Pa.
Kenneth Eugene Smith, 7008 Zimple St., New Orleans, La.; Ceramic Chemist, Newcomb College.
Clark S. Teitsworth, 2525 E. 37th St., Los Angeles, Calif.; Supervisor Process Laboratories, General Petroleum Corp. of Calif.
Richard Carl Zapfe, Ceramic Engineer, Pomona Tile Mfg. Co., Pomona, Calif.

STUDENT

Lewis F. Cole, Rutgers University, New Brunswick, N. J.
Henry R. Herron, Missouri School of Mines and Metallurgy, Rolla, Mo.
Venton Humphries, University of Toronto, Toronto, Ontario, Canada.
Gerald Leonard Johnson, Iowa State College, Ames, Iowa.
W. F. Sterns, Iowa State College, Ames, Iowa.

Membership Workers' Record

CORPORATION		PERSONAL	
Office	1	R. B. Gilmore	1
		C. S. Linder	1
STUDENT		A. L. Matthes	1
Paul E. Cox	1	W. J. Nicholson	1
C. M. Dodd	1	S. M. Phelps	1
Frank G. Heck	1	Mary G. Sheerer	1
R. J. Montgomery	1	Office	6
D. A. Moulton	1		
	–	Total	12
Total	5	Grand Total	18

ROSTER CHANGES

PERSONAL*

Byrnes, A. Marietta, M.S.C.W., Columbus, Miss. (Memphis Academy of Arts, Memphis, Tenn.)

* Addresses within the parentheses ( ) represent the old address.

These roster changes which are published each month may be checked against the complete Membership Roster which appeared in the July, 1929, issue of the *Bulletin*. Copies of this issue may be obtained from the Secretary's office, price $2.00.

Cochran, A. D., New Florence, Mo. (The Bonnot Co., Canton, Ohio.)
Crandall, James R., 2401 Pioneer Ave., South Hills Station, Pittsburgh, Pa. (325 Pitt St., Wilkinsburg, Pa.)
Cross, James A., Robinson Clay Products Co., Dover, Ohio. (Mogadore, Ohio.)
Dickey, H. R., Canadian Potteries, Ltd., St. Johns, Quebec. (Estevan, Sask., Canada.)
Freeman, Charles A., 427 Schofield Bldg., Cleveland, Ohio. (214 E. Monroe St., Mexico, Mo.)
Grogan, Glenroy G., 6787 Olmsted Ave., Chicago, Ill. (1366 Prairie Ave., Des Plaines, Ill.)
Howell, Harriet, 3551 Denchell Rd., Shaker Heights, Cleveland, Ohio. (3 Springland, Toronto, Canada.)
Moser, John L., 4972 Pasadena Ave., Los Angeles, Calif. (411 McKinley St., Middletown, Ohio.)
Palmer, Theodore H., Royall Fire Brick & Supply Corp., Houston, Texas. (A. P. Green Fire Brick Co., Mexico, Mo.)
Schoeninger, Irvin W., 1505 N. Franklin Pl., Milwaukee, Wis.; Globe-Union Mfg. Co. (6800 Normal Blvd., Chicago, Ill.)
Scott, Walter M., 73 Newbury St., Boston, Mass. (10 E. Franklin St., Baltimore, Md.)
Spencer-Strong, G. H., 403 E. Washington St., Sandusky, Ohio. (Templeton, Pa.)
Titsworth, Adelene, 327½ N. Vermont Ave., Los Angeles, Calif. (Sonyea, N. Y.)
Willson, B. W., 121 13th St. N. E., Mason City, Iowa. (Stevens Pottery, Ga.)

NOTES AND NEWS

NEWS FROM THE CERAMIC SCHOOLS

Clayworkers' Conference[1]

The Ceramic Department of the University of Alabama is planning to hold a Conference of Clayworkers at the University, February 2, 3, and 4, 1931.

The tentative program includes such matters as the processing of raw materials, the drying and firing of ceramic products, and the general subject of combustion with both gas and coal. This program, however, will be modified in order to deal with subjects in which particular interest is shown by members who will attend. These subjects will be discussed from both a theoretical and practical standpoint and it is believed that such a program will be of value to all interested in the above topics.

R. K. Hursh of the Ceramic Engineering Department, University of Illinois, and A. V. Henry and W. H. Vaughan of the Ceramic Engineering Department of the Georgia School of Technology will give a number of the lectures. Other authorities in the field of ceramics and combustion will be invited to appear on the program. No registration fee will be charged or donations solicited.

University of Illinois

A membership drive in the Student Branch of the American Ceramic Society was culminated November 13 with a dinner at the Delta Chi fraternity house. Fifty men from the membership of the Society and members of the research and teaching staff were entertained with a talk given by Capt. L. C. Parsons, Asst. Professor of Military Science and Tactics. An informal social meeting concluded the evening's activities. Chas. H. German, '31, was in charge of the dinner arrangements.

The officers of the Student Branch for the present year are: Carl H. Rapp, *President*, K. Dean Atkins, *Vice-President*, and Charles H. German, *Secretary-Treasurer*.

[1] T. N. McVay, Professor of Ceramics.

Robert J. Whitesell of the Ceramic Department was awarded a membership in the AMERICAN CERAMIC SOCIETY by the Alpha Chapter of Keramos, for having the highest scholarship average among all freshmen enrolled in the Ceramic Engineering Department for the school year 1929–1930.

New York State School of Clayworking and Ceramics

Three films on refractories were shown before the Student Branch of the AMERICAN CERAMIC SOCIETY at their meeting November 25, in Alumni Hall, using the new movie equipment. These films were taken in the Laclede-Christy plants and were obtained through the courtesy of the Bureau of Mines.

Illustrated lectures on ceramics are to be given by some of the members of Beta Pi Kappa before various high school audiences. These arrangements have been made by the students themselves and slides on different phases of ceramic products are to be used as descriptive matter.

Among the alumni who have recently called at the school are George E. Williams, '13, recently returned from Sidney, Australia, where he has been connected with Wunderlich, Ltd., Leon E. Smith, '22, of Glen Gary Company, Harrisburg, Pa., and Robert F. Sherwood, '18, of Syracuse, N. Y.

Leland Armstrong and Robert Bassett, '30, have recently accepted positions with Fiske & Company at Watsontown, Pa.

The Annual Christmas Festival and Sale of the Ceramic Guild held on December 5 was planned under the supervision of Clara K. Nelson and Marion Fosdick, professors of the Ceramic Department. It was in the atmosphere of a town of the Middle Ages, a village square with shops selling pottery, blockprinted linens, Christmas cards, wrappings, and candies. Refreshments were found in the kitchen of an old English inn where a costumed choir sang Christmas carols. The work was in charge of the Sophomore class assisted by the other classes.

An exhibition of pottery, paintings, and wood cuts by members of the faculty of the Art Department was held in the Art Department on December 12, 13, and 14. The exhibitors were as follows: Charles F. Binns, pottery; Marion L. Fosdick, pottery; Charles M. Harder, pottery; Clara K. Nelson, water colors; Luke Beckerman, oil paintings; and William E. Ross, wood cuts.

The International Art Exhibition at the Carnegie Museum in Pittsburgh was visited by a party of art students with Professor Nelson, the week-end of November 8.

THE OHIO CERAMIC INDUSTRIES ASSOCIATION

Monthly News Letter

During Depression—Prepare for Prosperity
Ceramic Short Course at Columbus

for

Managers—Superintendents—Foreman—Engineers and Plant Men
One Week: January 19 to 24, inclusive, 1931

The Department of Ceramic Engineering of the Ohio State University, at the request of, and assisted by, The Ohio Ceramic Industries Association, is again offering a one week short course for practical ceramic men.

The outstanding features of this course are as follows:

(*a*) Separate courses in structural clay products, refractories, whiteware, and metal enamels.
(*b*) Fundamental technology and its application by the practical man simply explained.
(*c*) An effective staff of teachers drawn from college professors and outstanding men in the ceramic industries.
(*d*) The privilege of spending all week studying one subject or dividing your time between several subjects.
(*e*) Moving pictures of various types of ceramic manufacture.
(*f*) Demonstrations of tests of ceramic products.
(*g*) A small cost, only $5.00 tuition per individual for the entire course.

If interested write to the Department of Ceramic Engineering, Lord Hall, Ohio State University, Columbus, Ohio, for details.

PROGRESS WORK OF THE WISCONSIN CLAY PRODUCTS MANUFACTURERS ASSOCIATION

The University of Wisconsin,
College of Mechanics and Engineering,
Madison, Wis.
December 8, 1930.

Dear Mr. Purdy:

I wish to thank you for the interest you have shown in our Wisconsin Clay Products Manufacturers, and I am only too glad to send you the following information regarding our work.

Two years ago the idea was conceived that the Wisconsin clay products manufacturers should form an organization to promote their interests. Accordingly, through the assistance of the Engineering College of the University of Wisconsin, an organization meeting was held. It was found that here in Wisconsin a peculiar situation existed. The majority of the manufacturers are what might be termed small organizations who manufacture for local consumption, and ship their ware only a short distance. Consequently, the manufacturer in one part of the state does not know the other manufacturer only a short distance from him. With a condition of this kind existing, we found there was no real coöperative effort. The association we now have of the Wisconsin Clay Products Manufacturers has introduced a new feeling of assistance to the different separate members.

It was deemed advisable first to better the clay products made in this state. Our State Geologist advises that we have a variety of clays suitable for the manufacture of a large range of clay products. The important question is the method of treating the different types of clay. We find that there are practically no two plants in this state operating on exactly the same type of clay. Each one is different. With this condition

existing it was thought advisable to seek expert assistance in the study of the wide variety of clays.

Accordingly, the association voted to establish a fellowship in Ceramics at the University of Wisconsin. William Whitney, graduate of the Ceramic Department, University of Illinois, now holds this fellowship. In the short two years during which he has been working, considerable progress has been made in supplying information to the separate plants as to the manner in which they should handle their clay. In many cases, vast improvement has been made in the quality of the product. At the present time, we are manufacturing in some of our plants, face brick, building tile, drain tile, and common brick that are of a higher quality than the majority of material now being shipped into this state.

Primarily, our Association is only a local state organization. Our aim is to assist each individual manufacturer. We hold about four meetings a year, some of which have rather lengthy technical programs and other meetings are devoted solely to the individual problems confronting our own manufacturer. The business affairs of our Association are conducted by an Executive Board, consisting at the present time of R. H. Downes, Oshkosh, A. O. Zerrenner, New London, Jacob Hockers, Depere, and the Secretary.

Another work we are doing in this department is a coöperative research with the Wisconsin Lime Manufacturers. They also have created a fellowship in the Engineering College for the study of Wisconsin high-magnesia limes. Considerable work has already been done and preliminary results only obtained to this date. If you should be interested in this line of work, I will gladly furnish you with the results of our experiments as soon as they are ready for release. This, however, will not be for at least another nine months.

Trusting that I shall have an opportunity of personally meeting you at the Meeting of the AMERICAN CERAMIC SOCIETY in February, I remain,

Yours very truly,
PROF. G. J. BARKER, *Secretary*
Wisconsin Clay Products Manufacturers Assn.

CHANGE AND THE IRON AND STEEL INDUSTRY*

We are living in a world of change. It would be so if no progress were being made, as change is an immutable law of life.

In no field of human effort can we find more of a far-reaching revolutionary change than in that of American industry. With the history of the last twenty-five years before us we can, however, readily see that the factor of change, as known to earlier generations, has now become increasingly cumulative in its effect upon commerce and finance and still more dramatically so in scientific development and in industry.

Business of almost every nature has in fact been going through a revolutionary change in its method of operation and of management. It has been changing old habits, old ideas, and old ways for new ones.

Change is now so much a factor in our daily lives that it has become individually and collectively a good deal of a struggle to keep up with it.

Civilization itself has followed along the highway of progress through the adoption of new forms of transportation and of communication and in development of the old.

Most marvelous changes have taken place in our modes of transportation during the past seven years and more particularly in the last 25 years. We have literally taken "unto the wings of the wind" and the end is far from sight. Just what all of these changes have meant to our country and to all of the other nations of the world cannot as yet be fully understood or appreciated, as such things can only be appraised after much time has elapsed. We do know that we are living in a new world, a world of

* Editorial reprinted from *The Pure Iron Era*, **3** [11], 1 (1930).

new conceptions, of new desires and aspirations, and that both individual life and business must adjust themselves as rapidly as possible to the new conditions which exist.

Scientific development has gone ahead with such leaps and bounds that we now see a new and vaster universe all around us than we heretofore knew, and we are rapidly becoming informed as to living conditions existing on our more nearby planetary neighbors. Living in a world of such rapid and marvelous changes and knowing as we do, that life itself is dynamic and not static, we realize that our great aggregations of capital, equipment, and human energy called business, must and will go ahead to still greater accomplishment, backed, supported, and urged on as they will be by the great and unconquerable spirit of adventure that burns in the hearts of the men of all nations.

RESEARCH, THE PATHFINDER*

In every great organization there is always some one who is looking ahead—not just planning for future production, but trying to visualize the changing needs and demands of the world's growing population. We sense trends which many times eventually lead us into entirely new fields. We see old products, as well as old plants, entirely abandoned by the ruthless charge of progress.

The competition is by no means restricted to industries in the same line of business. It is a competition between all products that serve human needs. Education inspires a desire for new things, and the old reticence to change which has inflicted civilization for centuries is being lessened with each succeeding generation.

The research men of the world are its pathfinders, men who in laboratory and shop are continually thinking ahead of our demands and of our needs also.

Sound research is established to solve a problem, perfect a piece of mechanism, or produce something entirely new that makes living more enjoyable. Good products must be made better, or perhaps a product of the same quality will enjoy a wider market if it can be made more economically and sold at a lower price. Then, too, there are still opportunities for perfecting machinery to do the arduous labor that falls on the backs of men, machinery that will do it faster, better, and more economically.

This was the thought behind the scientific research which resulted in the perfection of great continuous mills for rolling wide, thin, sheet metal recently developed by The American Rolling Mill Company.

Not since 1759 had there been any change in the basic method used by the world's sheet-rolling plants until the continuous mill was installed by Armco in their Ashland, Kentucky, plant. Although it had been the dream of engineers for years, and the plan had been tried without success, it remained for some one to first solve the idea in his own mind.

Bankers, industrialists, and scientists are today greatly interested in the research movement. A recent tour under the direction of the National Research Council brought together one hundred leading business executives who spent an entire week visiting the outstanding laboratories of the United States. A research man realizes that a new idea may have to wait until, through education, the public is ready to adopt it. Education makes people dissatisfied with what they have, and then they reach for the new. Every day, on the fast-moving stage of progress, research men have the joy of seeing some idea or product accepted, even by those who predicted it a wild dream only a short time before.

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* Editorial reprinted from *The Pure Iron Era*, **3** [11], 3 (1930).

SEEING IS BELIEVING[1]

National Research Council Tour Visits Leading Industrial Laboratories in the United States

By Hugh W. Wright

If the world had not experienced the greatest war of history just a few short years ago, perhaps modern industry would be sliding along at the same old speed. But there was a war, and dire need forced industry to search and research for new products, new equipment, new practices, and new thoughts. It no longer remained a matter of choice; self preservation demanded that industrialists heave mightily on their own boot straps.

The business men of the world began to see the results of research take tangible form before their very eyes. They began to realize that perhaps research was not a part of the Black Art as many of them had believed. They knew then, that those companies which were already active in the field were wisely managed; that they had a head start on those who held to the old ideas.

Research sold itself to the world by visible salesmanship, by a dazzling display of the products it had created.

The war ended, suddenly and abruptly. From a period of plenty, industry was plunged into one in which the factors of cost, quality, and service became predominant. Competition, that great vitalizing force, became all powerful, driving many industries into extended research activities as a protective and progressive measure.

But since the war, competition has never lessened; on the contrary it has grown more intense. In proportion, research activities have grown. In 1921 there were five hundred industrial research laboratories in the United States; today there are more than fifteen hundred, a two hundred percent increase in those nine years.

Nearly $750,000 is spent every working day in the United States to improve the manufacturing processes, reduce production costs, and develop new fields of applications and by-products in the nation's industries. That tells the story of this new economic trend.

The Tour to See

The National Research Council is a coöperative organization which is devoted to the extension and improvement of industrial research.

As a means of promoting interest on a nation-wide scale in what is being done by the leaders in research, the divisions of engineering and industrial research of this Council recently arranged a tour of 100 prominent industrial executives and bankers. Its purpose was to demonstrate to these men the importance, value, and varied applications of research in industry, and by personal observation, to study the extent of operation, and to compare the different types of research organization, problems selected, and methods developed for their solution in a few outstanding industrial laboratories.

The tour was started in New York City on October 7, with an inspection of the Bell Telephone laboratories. Other laboratories on the itinerary were: The General Electric Company plant and laboratory at Schenectady, New York; the General Motors Research Laboratories and Proving Grounds at Detroit, Michigan; the Engineering Division of the U. S. Air Service at Wright Field, Dayton, Ohio; the American Rolling Mill Company laboratories at Middletown, Ohio; the Aluminum Company of America, and the Mellon Institute of Industrial Research, both at Pittsburgh, Pennsyl-

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[1] Reprinted from *The Pure Iron Era*, **3** [11], 10 (1930).

vania; the United States Bureau of Standards and the National Canners' Association laboratories, both in Washington, D. C. Diversity and prominence in research work were the two factors considered in arranging the itinerary.

A RADIOGRAM FROM CHINA

In response to a letter urging ceramic graduates to take a more active interest in the AMERICAN CERAMIC SOCIETY, I received the following radiogram:

Peiping, China, Dec. 6, 1930

Professor Watts,
Ohio State University, Columbus, Ohio.
Inspired by your letter, trying to unite returned ceramists in promoting ceramic materials research solicit your guidance.

C. C. LIN

This is the same Lin who was the moving spirit a few years ago in presenting to the Ceramic Engineering Department of Ohio State University the splendid painting on porcelain of General Edward Orton.

Ohio State University now has nine ceramic engineering graduates who came from China and have returned there to promote modern methods in ceramic manufacture. They are fortunate in having Lin as a leader, and we shall learn much of interest and value regarding Chinese ceramic materials and products from this group.

ARTHUR S. WATTS, CHAIRMAN,
Ceramic Engineering Dept.,
Ohio State University.

CALENDAR OF MEETINGS

Organization	Date	Place
American Assn. for the Advancement of Science	December 28, 1931 to January 2, 1932	New Orleans, La.
AMERICAN CERAMIC SOCIETY	February 22—28	Cleveland, Ohio
American Chemical Society	March 30 to April 3	Indianapolis, Ind.
American Concrete Institute	February 24–26	Milwaukee, Wis.
American Electrochemical Society	April 23–25	Birmingham, Ala.
American Foundrymen's Assn.	May 4 to 7	Chicago, Ill.
American Gas Assn.	October 12–18	Atlantic City, N. J.
American Glassware Mfrs.	July	Atlantic City, N. J.
American Institute of Chemical Engineers	June	Swampscott, Mass.
American Institute of the City of New York	January 10	New York, N. Y.
American Institute of Mining and Metallurgical Engineers	February 16–19	New York, N. Y.
American Refractories Inst.	February 22–28	Cleveland, Ohio
American Society of Mechanical Engineers	April 20–23	Birmingham, Ala.
American Society for Testing Materials	June 22–26	Chicago, Ill.
Common Brick Mfrs. Assn. of America	February 1–6	Philadelphia, Pa.
Gypsum Assn.	March 11	Chicago, Ill.

National Assn. of Mfrs. of Heating and Cooking Appliances	May	New York, N. Y.
National Assn. of Mfrs. of Pressed & Blown Glassware	March 10	Pittsburgh, Pa.
National Brick Mfrs. Assn.	February 22–28	Cleveland, Ohio
National Exposition of Power and Mechanical Engineering	Dec. 5–10	New York, N. Y.
National Glass Distributors Assn.	Dec. 1–3, 1931	Pittsburgh, Pa.
National Paving Brick Mfrs. Assn.	February 4–6	Pittsburgh, Pa.
National Safety Council	October 12–16	Chicago, Ill.
New Jersey Clay Workers Assn.	June	Asbury Park, N. J.
Optical Society of America	February 26–28	New York, N. Y.
Sand-Lime Brick Assn.	February 3–5	Atlanta, Ga.
Scientific Apparatus Makers of America	May	Newport, R. I.
Structural Clay Tile Assn.	February 19–20	Chicago, Ill.
Taylor Society, Inc.	May 1 and 2	Philadelphia, Pa.
Tile & Mantel Contractors' Assn.	April 14–17	Milwaukee, Wis.

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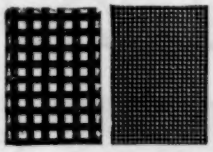

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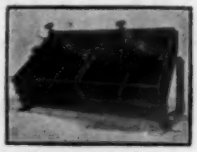

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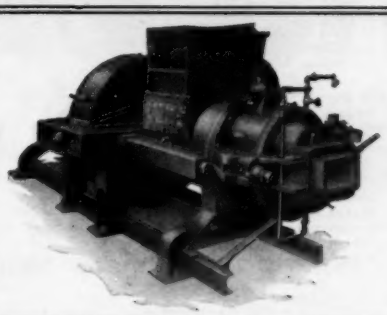

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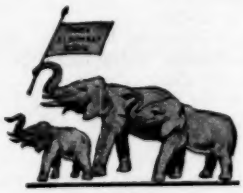

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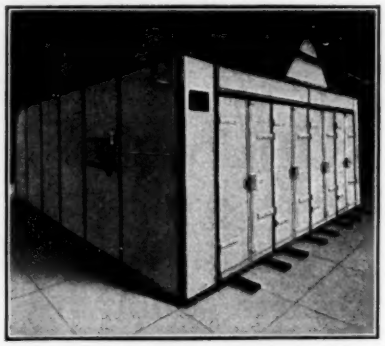

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